Vol. IV. — No. 3. March, 1922.

BULLETIN

OF THE

INTERNATIONAL RAILWAY ASSOCIATION

(ENGLISH EDITION)

[656 .223.2]

REPORT No. 2

(all countries, except America)

ON THE QUESTION OF INTERCHANGE OF ROLLING STOCK (SUBJECT XV FOR DISCUSSION AT THE NINTH CONGRESS OF THE INTERNATIONAL RAILWAY ASSOCIATION), (1)

By Mr. CHARRON,

ASSISTANT CHIEF ENGINEER OF TRAFFIC OF THE FRENCH MIDI RAILWAYS.

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(1) This question runs as follows : « Interchange of goods rolling stock (freight cars), and penalty charges in case of delay in the return of that stock : *a*) rules to be adopted in the relations between the railways themselves; *b*) rules to be adopted in the relations between the railways and the consignors and consignees. »

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GENERAL CONSIDERATIONS.

The question has already been discussed at the fourth session of the Congress (St. Petersburg 1892). It has again been included in the programme of the Congress for its next session (Rome 1922) at the request made at the preceding session by Mr. W. F. Allen, general secretary and treasurer of the American Railway Association on behalf of the Administrations of American Railways, who desired, for their own investigation of the subject, to benefit by the experience of the railways of other countries where regulations relating to the interchange of wagons have made appreciable progress.

The question however has been asked in more general terms than in 1892; it has in fact on the one hand been made to cover interchange of all stock, instead of limiting itself to rolling stock only; it includes therefore on this occasion not only the wagons, but also the loose fittings which are likely to accompany them (sheets, ropes, wedges, etc.); on the other hand it not only aims at procuring information respecting the relations between railway administrations, but also that which concerns the relations between these administrations and the consignors and consignees.

It differs also in this respect that when in 1892 the question had been made the subject of one report only, this time the enquiry has been divided between two reporters. The present report should in principle concern all the participating countries except America, that is to say :

Belgium;
China (*);
Denmark;
Egypt;
Spain;
France and Colonies;
Great Britain;
India and other British Colonies or Dominions;
Greece (*);
Italy;
Norway (*);
Holland;
Portugal;
Roumania (*);
Serbia (*);
Sweden;
Switzerland.

As a matter of fact, however, no administration belonging to the countries marked with an asterisk (*) and also to the International Association has replied to the list of questions. It must therefore be understood that generally in what follows, the remarks and conclusions apply only to the other countries.

Before commencing our report, we think it may be interesting to point out that under the modest title of « Note on the usefulness of studying the question concerning the interchange of goods rolling stock and charges for detention », Mr. W. F. Allen in reality presented to the eighth session a Note (1) upholding his proposition, accompanied with many documents in which already figures a portion of the information since sent in by the administrations in reply to our list of questions, a courtesy for which we tender our best thanks. These replies, however, have brought to light important

(1) This note and its appendices were reproduced in the *Bulletin of the International Railway Congress* of January 1910, pages 10 to 237.

changes that have either been made, or are contemplated in the « conventions » which were in force at the time when Mr. W. F. Allen was making his enquiry (1909). We will deal therefore more particularly with this new matter, offering our excuses for not being able, on account of the necessity under present circumstances, of reducing the cost of printing, to reproduce them *in extenso*, as had been possible with information gathered by Mr. W. F. Allen.

On the other hand, we have to take into account present circumstances in the parts of our report relating to rates (charges), penalties and other questions in which the element « Money » comes in. The figures which could be given as regards this would in fact more often be without significance for the following reasons. In the first place, the purchasing power of money has declined during recent years. Secondly, this curtailment has curiously varied from one country to another on account of fluctuations in the exchange. Finally, in order to take into account the increase in their working expenses, the railway administrations have been obliged from time to time to raise their rates or tariffs for accessory costs (handling, station expenses, rates for demurrage, etc.) and these changes still follow one another in such a way that the information collected on this subject cannot, except in very exceptional cases, offer any comparison having a definite significance. When therefore we reproduce such figures, it will rather be to facilitate drawing up the report than with the intention of their being looked upon as of real value.

Our work will be divided into two parts, corresponding respectively to the two paragraphs of question XV, and each part will be sub-divided in its turn into a certain number of chapters dealing with the following subjects :

PART I.

RAILWAY ADMINISTRATIONS.
RELATIONS BETWEEN EACH OTHER.

CHAPTER I. — Rules, regulations, agreements and « conventions ».

CHAPTER II. — Wagons.

CHAPTER III. — Loose fittings.

CHAPTER IV. — Interchange charges.

CHAPTER V. — Rules dealing with disputes.

PART II.

RELATIONS BETWEEN RAILWAY ADMINISTRATIONS AND CONSIGNORS AND CONSIGNEES.

CHAPTER VI. — Consignments dispatched from or received at stations.

CHAPTER VII. — Consignments dispatched from or received at private sidings.

CHAPTER VIII. — Traders wagons.

CHAPTER IX. — Supply of loose fittings to consignors.

PART I.

RAILWAY ADMINISTRATIONS.
RELATIONS BETWEEN THEMSELVES.

CHAPTER I.

Rules, regulations, agreements and « conventions ».

The wholesale transhipment of goods from one line to another at an exchange

point is a very cumbersome and out of date method. It necessitates the provision of special accommodation, involves additional labour, expenses, delay to traffic, and risk of damage and miscarriage. The different railway administrations therefore arrange amongst themselves, in all (1) countries to which this report refers, for the transfer of loaded wagons from one system to another. At the beginning, these reciprocal interchanges were generally the result of a « convention » between two administrations, but in most countries the fact was recognised that the adoption of a uniform system of interchange would be mutually helpful in effecting economies in interchange arrangements in regard to transportation of traffic, except in the matter of a few particulars in the « conventions » agreed to between any two companies who would arrange between themselves questions of detail outside the regulations common to a number of companies.

It is in this way that general understandings (2) have been come to between systems belonging to :

1° The same country, *i. e.* :
Belgium (Light railways);
Denmark;
France;
Great Britain;
British India;
Sweden;
Switzerland.

2° Different countries, the enumeration of which will be given when the examination of each one of these agreements is gone into.

(1) With the reservations mentioned in « General considerations ».

(2) The word « Convention » will be used in the course of this report to designate arrangements come to under the name of agreements, regulations, conventions, etc.

The system adopted by the Belgian Light Railways consists of a typical « convention » which forms the base for those « conventions » that were effected between companies of light railways acting in pairs; « conventions » thus concluded are submitted for the approval of the Council of Administration of the National Society of Light Railways.

The arrangements for interchange between the Danish railways are regulated by a « convention » which is a reproduction in its essential parts — nearly identical in fact with those which regulate the international interchanges of the Scandinavian railways.

The present French system put into force 1 April 1920 is explained in a document entitled : « Rules for operating goods rolling stock on the French railway systems », which defines the relations of the affiliated railway administrations, who may refer, however, when there is any opposition to « Rules for use in common and reciprocal working of rolling stock » which have been in operation for many years, the most interesting clauses of which having been reproduced in the work of Mr. W. F. Allen.

The French administrations came to a mutual agreement, on the 18 August 1899 concerning damage to interchange rolling stock, an agreement with which the Italian State and the Belgian State Railways have also associated themselves.

In Great Britain, the rules and regulations relative to interchanged rolling stock are arranged through the medium of the institution called « Railway Clearing House » which was started in 1842 and has since become the central office for settling matters between all the British railways with reference to direct transport of passengers or freight, the reciprocal use of rolling stock, the classification in common of all goods, rebates

in charges, methods of loading, services of freight trains, the principles of apportioning the receipts, responsibility, etc. Questions relating to the interchange of rolling stock are the subject of articles 226 to 258 (Coaching stock) and articles 275 to 327 (Merchandise stock) of the Railway Clearing House Regulations dated 1 October 1914, and articles 6 to 10 of those Regulations explain how the Railway Clearing House Conferences are constituted and under what conditions the representatives of the companies concerned meet to examine and discuss questions brought forward by these companies, and agree to any alterations in the Regulations which from time to time may be considered desirable.

The method of working as explained above has been completely altered during the war, and the question of doing away with or modifying the systems put into operation during the period of Government control was still being considered in January 1921.

In British India, the regulations are arranged by the « Indian Railway Conference Association » under the title of « Rules and regulations for the interchange of through traffic ». All the Indian companies have not entered into this scheme, and those that have may arrange between themselves to make certain modifications in these « Rules and regulations ». This code of rules has recently been altered, as an experiment, important modifications having been put into operation since the 1 January 1921 on some of the railways.

In Sweden, one « convention » only regulates the interchange between the various railways in the interior working of that country, and is practically a reproduction, as regards the technical conditions of admission, interchange and settling costs due to damage, of the International Scandinavian « Convention ».

In Switzerland, the various railway administrations have for many years had in operation for the common use of their goods rolling stock, an Association called « Swiss Rolling Stock Association » which has arranged a « convention » that settles all matters with which it has to deal. They have also combined as regards everything that concerns technical conditions allowing interchange according to the « Technical Rules » of which the principal clauses are an exact reproduction of the « International Regulation relating to technical standardisation » which will be dealt with later on.

Several « conventions » are in operation between administrations belonging to different countries, which govern all administrations of the contracting countries in matters concerning international interchange of rolling stock.

These are :

a) Regulations for the reciprocal use of rolling stock on lines belonging to railway administrations forming part of the « International Union » (1) (1882 edition) and the technical regulations for the reciprocal adoption of (transport) rolling stock and responsibility for damage (1913) edition which is a supplement to the former.

b) Regulations under the name of « German-Italian-Union » (I. W. R.) (1 April 1914 edition) relating to the reciprocal use of wagons working the traffic between the Italian railways on the one hand, and the German, Austrian, Hungarian, Bosnian, Herzegovinian, Swiss, Belgian, Dutch, Luxemburg, Roumanian railways, and the Warsaw to Vienna railway on the other. This code

(1) Belgian, German, Austrian-Hungarian, Danish, Swedish and Norwegian, Roumanian, Serbian, Bulgarian and Turkish Railways, French Nord and Warsaw to Vienna Railways.

not only deals with interchange arrangements properly so called, but also the technical conditions relating to interchange and the rules relating to damage. In addition to the relations as defined above, it equally applies to the interchange between the Belgian and Swiss railways through German territory.

These « conventions » are to be replaced very shortly, as well as a series of « conventions » between two parties connecting some of the French administrations with those of neighbouring countries (1) by a sole International Convention (2) now in preparation and which is arranged on lines sensibly different from those « conventions » which it will take the place of as regards interchange accounts and charges and the regulations concerning damages to vehicles, but which in most other respects is similar to the code drawn up for the German-Italian Union;

c) « Regulations dealing with the technical standardisation of railways » which, since the 1 July 1908, embrace the majority of the European continental countries which have the standard gauge on which the present investigation is based (3). This code which was got out in 1907 by the third Conference at Berne specifies the technical conditions that must be observed for the interchange to take place. It has been incorporated with some supplementary clauses in the Regulations of the German-Italian Union. It does not necessarily operate between the different administrations of any particular adhering country, but these are at liberty to take advantage of the arrangements, as was pointed out when dealing with Switzerland; the same applies to the Danish and Italian railways.

d) Regulations for the reciprocal use of rolling stock within the compass of the Union of German railways (Vereinswagenübereinkommen = V. W. U.), which regulates the interchange relations between the Netherlands, Scandinavian Countries, Roumania and Germany, and with the exception of a few details, has been adopted by the Scandinavian Countries in their relations between themselves. This code contains a number of clauses common to that of the German-Italian Union, and will be, like the I. W. R., replaced by the R. I. V.

(1) In order to simplify the present report, no mention will be made of the « conventions » which will disappear when the new International Convention comes into operation; the reader desirous of studying them will find the essential parts in the appendices to the article by Mr. W. F. Allen.

(2) This « convention » which will be called « R. I. V. » in the present report is entitled « Regulations for the reciprocal use of vehicles in international traffic » and was first put forward for consideration on the initiative of Italy; up to now Germany, Austria, Bulgaria, Czecho-Slovakia, France, Greece, Italy, Holland, Luxemburg, Poland, Kingdom of Serbia, Croates-Slovenes, Roumania, Hungary, Austrian Southern Railway, Sweden, Switzerland and Turkey, have participated in preparing it.

(3) Belgium, Bulgaria, Denmark, France, Greece, Italy, Luxemburg, Serbia, Norway, Holland, Roumania, Sweden, Switzerland.

CHAPTER II.

Wagons.

§ 1.

CONDITIONS OF ADMISSION TO INTERCHANGE ARRANGEMENTS.

A. — Technical conditions.

Between lines in the same country — with the exception mentioned above relating to Denmark, Italy and Switzerland — the stipulation for admission to interchange is generally limited to insisting that the wagons shall be in a good working condition, so that the risk in transit

to both the wagons or goods may be minimised.

Certain systems have, however, been obliged to issue more definite rules on account of their loading gauge, the maximum load per axle their line could safely carry, minimum radius of curves, etc.; these rules, however, are binding on one party only, they cannot be made the subject of « conventions », and are of course to be opposable to all adjoining railways, whatever may be the conditions relating to interchange that have been agreed to with these particular administrations.

We have seen above that the rules in vogue between railway systems in different countries resulted in the regulations drawn up in 1907 (1) by the third Conference at Berne, and completed by a few additions (2) from a set of rules put into force 1 April 1914 by the German-Italian Union.

B. — **Minimum load and minimum distance to be run on the receiving line.**

Some administrations impose no restrictions (Belgian Light Railways).

Others require a fixed minimum loading (1, 2, 3 (3) or 4 (4) tons) independent of the distance run, which is sometimes greater with slow than with fast trains, but capable of being dispensed with in the case of traffic occupying a large space for little weight such as hay and straw. In France the minimum allowed varies with the distance; the wagons should in principle contain for a given station the weight of goods mentioned below either for transhipping at the station or for distribution at stations further on by the wagon in question :

Two tons for a distance less than 400 km. (250 miles) starting from the junction station.

Four tons for a distance equal to or exceeding 400 km. from the same starting point.

In exceptional cases, wagons are accepted unconditionally with regard to weight and mileage if they have been sealed by the customs, and also sealed wagons loaded with particularly dangerous explosives.

Other administrations stipulate a minimum that is not rigidly fixed as regards weight, but according to the maximum load the wagon is capable of carrying; the amount insisted upon varies from 20 to 67 %; being in most cases 40 to 50 %.

The latter basis is not quite so easy for the staff to apply, as the preceding ones, for the way-bills accompanying the goods do not indicate clearly enough, at least in France, the maximum load the wagon is built to carry, and so do not allow the staff at the junction station to check whether the loading is sufficient or not to justify the continuation of the journey without transhipping. The forwarding railway has everything to gain by conserving its large capacity wagons. It seems therefore that where maximum loading is not adopted as the base for rate, it is not worth while fixing a minimum weight to justify interchange.

C. — **Essential documents. — Conveyance of rolling stock and traffic.**

Nearly all administrations have arranged to only accept a wagon at a junction

(1) Revised on several occasions, the last time in 1913.

(2) These additional arrangements only apply of course to the rolling stock interchanged according to the « Convention » of the German-Italian Union.

(3) The fixed minimum reaches even 5 t. in the agreements between the Portuguese Railway Company and that of Madrid-Caceres-Portugal.

(4) In order to facilitate the working of this clause, the Spanish « Conventions » stipulate that the delivering company must fix a label on the wagon indicating its destination and the weight of its loading.

station when they have made certain that nothing will prevent its being delivered to the consignee.

The question is generally settled in the following manner in most of the International « conventions » :

The wagons are considered as delivered when they are placed at the disposal of the receiving administration, accompanied by all the necessary documents (waybills, advice notes, customs papers, etc.) which must accompany the freight they concern.

The various « conventions » arrived at between the railways of the Iberian Peninsular stipulate that in order to be admitted on the neighbouring line every wagon of a company must carry on each side a label stating :

1° The place it came from;

2° The date of departure;

3° The place of its destination;

4° A general description of the load and the weight.

A vehicle is not considered as delivered so long as the receiving company has not received all the documents which, according to legal requirements and regulations, must accompany the goods.

If the documents have been delayed and it is necessary to forward the consignment, the receiving company will accept the wagons conditionally and will notify this on the interchange papers mentioning the precautions taken, as much on account of the missing documents as well as for any other neglect which may have occurred. When, in consequence of the absence of these documents or on account of any error contained in them, the consignee is unable to take possession of his goods, responsibility for the time lost shall not fall upon the terminal company.

When a consignment made up of two or more wagons arrives incomplete at a junction station, the receiving company will accept the wagons which are delivered to it conditionally, and if these wagons are subjected to extra delay in consequence of having to wait for the remainder of the consignment, this delay will be deducted from the accounts according to the conditions provided for in the last paragraph.

There are no explicit rules concerning this question either in the regulations of the « Railway Clearing House » of Great Britain, or in those of the « Association for the working of Swiss rolling stock ». Such a contingency in view of the through booking arrangements does not arise on British railways, but should wagons have to be held up short of consignee in consequence of default on the part of the railway company, that company takes the responsibility. The rules of the « Indian Railway Conference Association » provide only for the case, where the destination being known, the wagon is not routed, although there is a choice of several routes. The chief official at the junction station should wire for these particulars both to the dispatching station and the destination. Should there be no reply within forty eight hours, he forwards the consignment by the shortest route.

§ 2.

PROOF OF DELIVERY WHEN ENTERING AND RETURNING FROM RECEIVING LINE.

This checking is generally done by an official of the junction station when it is the joint office of the two interested administrations. In certain cases (Bel-

gian Light Railways, Spanish Railways, Italian State Railways, and always when the two administrations belong to different countries) the accounts are made out separately by officials of each company.

The time of receipt and of handing back are not by any means uniformly fixed. Generally wagons are considered delivered from the time they are placed in the hands of the receiving administration when the documents that should accompany them (way-bills, advice notes, customs papers, etc.) being handed over, any damage that may have occurred to the wagons having been noted by both parties. In other « conventions », the delay allowed for the return of the wagon is only counted from the day it was taken on by a train belonging to the receiving line (1). Some reckon this from the day of the arrival of the train from the forwarding company, others reckon the time from the day following the receipt of the wagons at the junction station, stipulating that if all the wagons of a consignment cannot for certain reasons be sent on together from this station, then the time calculated for the reception of the stock shall count only from when the last wagon of the consignment arrived. When the agreed time is counted by hours or half days, the « conventions » usually stipulate 2 or 3 deliveries daily at stated times. For handing back, the rules applicable between French lines stipulate that vehicle-units (particular vehicles) corresponding to the wagons present in a joint station belonging to several companies are distributed between them in proportion based on the working conditions of the station.

According to the rule in vogue, the duration of stay charged to the receiving railway may vary from one to two days; it may be admitted that this difference is of small importance when the number of wagons given up by each administration to the other is about the same, for in this case there is compensation between the days gained and lost, but it is otherwise when the number of interchanged wagons do not balance, and in this hypothesis it is evidently in the interest of the company which delivers the most wagons, that these should be taken in hand by the receiving railway as soon as possible and returned as late as possible after the arrival of the wagon in the joint station.

From the point of view of drawing up the interchange accounts, the system which is simplest in application is that which consists in placing foreign wagons in the hands of the receiving company only from the time they leave the joint station to the time they return (2). All the particulars relating to the account are in fact thus found in the returns of the trains of the receiving company, and it is therefore not necessary to examine the returns of the company who have worked the stock to the point of exchange, nor to take note of the delays in the arrival of documents which should accompany the wagon, the period during which a wagon is stopped for repairs being ignored, or in it being kept from work on account of repairs.

(1) The « Conventions » of the Italian State Railways with certain secondary lines, however, stipulate for a maximum delay of eight hours, from the time of the arrival in the junction station before taking it in hand. The projected R. I. V. « Convention » specifies that the wagons received or returned each day shall be considered as delivered at the following midnight.

(2) This system comes to the same thing as leaving the detention of the wagons in the hands of the parent line (or delivering lines as regards similar wagons).

§ 3.

POSSIBILITY OF USING ROLLING STOCK ON RETURN JOURNEY.

Permission is always given — and it is often stipulated that foreign wagons *must* be returned loaded as far as possible — though generally some restrictions are attached; for instance it is often only allowed when its destination is the parent line or beyond; it may or may not be made to depend on its being returned to the station it was handed over at; occasionally permission is granted to its being loaded to stations on the way back to the joint station where it should be returned, or to branch lines as long as the distance covered from the direct route does not exceed a certain limit. In the Spanish « conventions » and in the rules of the « Indian Railway Conference Association » the use of foreign rolling stock is even allowed between stations on the receiving line, but the loading for a line other than that of the owning company is not allowed unless the latter's line is run over by the wagon to reach its destination.

The regulations between the French lines stipulate that the wagons belonging to one company and forwarded to another should be returned to the owning railway and as far as possible loaded.

In case it cannot be made use of on the spot, the vehicle may be forwarded empty to pick up over a radius of 50 km. (31 miles) round the station which received it when loaded.

The projected R. I. V. stipulates that foreign wagons should be returned without delay and if possible loaded. These new loadings must be consigned to :

a) A station belonging to the owning railway;

b) A station situated beyond the owning administration on condition that the latter shall be crossed to reach it;

c) A station situated on the route of the outward journey;

d) Any station situated in the direction of the owning railway provided that the running draws the wagon nearer to the owning railway.

In all cases the freight can be forwarded on any route.

In case they cannot be utilised under these conditions, the wagons are returned empty :

a) By the stations on the outward journey, to the transit stations by which they had been received;

b) By the stations which have not been touched on the outward journey, to the nearest booked point of this journey, or else to the nearest transit station of the owning line, according to its proximity.

§ 4.

BASIS ON WHICH THE HIRE AND PENALTY CHARGES FOR THE USE OF THE INTERCHANGE STOCK ARE CALCULATED.

The units generally considered are the wagon and the axle. Occasionally different charges are made for different classes of wagons. In Great Britain, for instance, the regulations of the « Railway Clearing House » specify in article 280, the rates at which mileage is charged for various classes of wagons according to their type, dimensions, nature and weight of load; Railway Clearing House Regulation 296 (demurrage) provides for penalty charges per vehicle per day for the detention of stock on other companies' lines beyond a stipulated time. The Regulations of the International Union class their wagons into those with a tonnage

of 15 and below and those exceeding that tonnage, in order to fix the rates for mileage as well as the charges for time.

The Belgian Light Railways made a distinction between 10 ton wagons and those of 5 tons.

Amongst the administrations which continue to use the « wagon » unit, several have really substituted for it the « axle » unit stipulating for instance that a bogie vehicle shall be counted as two vehicles with four wheels, and a wagon with six wheels on the metre gauge as a wagon and a half (1); the choice of the unit appears therefore to become increasingly limited to the axle or as a variant to these two bases, to the classification of the rolling stock into several categories each rated differently (2).

It is to this last method that the French lines gave their adherence at their recent « convention ». It was put forward in principle that the various types of wagons belonging to the companies are not all considered as being equivalent to one another. They are distinguished by three classes : flat, covered and open trucks for each of which entirely distinct accounts are kept. The wagons of each one of these classes enter into the reckoning after applying a coefficient (3) representing the mean value of the vehicle belonging to each one of these classes for each company relative to the typical unit adopted and called the vehicle-unit. For each one of these classes the respective unit is given as follows :

a) The flat 10 ton wagons of standard size and capacity;

b) The covered 10 ton wagons of standard size and capacity;

c) The open 10 ton truck of standard size and capacity.

It was then determined, according to the state of the required stock of the various participating lines and for each one of these three classes the values in vehicle-units of the « average-wagon », by taking into consideration the practical value in the use of vehicles of larger or smaller size and capacity than those of the unit-types mentioned in the previous paragraph.

This arrangement should, in principle, be revised at the beginning of each year so that account may be taken of any alterations that may have been made to the rolling stock during the course of the preceding year.

Simplicity is the only advantage gained by the adoption of the wagon as unit (1), it however becomes less and less reasonable as the difference between

(1) Rules and Regulations of the « Indian Railway Conference Association » edition put into operation 1 January 1913. It is interesting to point out this particularity as a list of rules which is comparatively recent and in use on a railway system of 42 000 km. (26 100 miles).

(2) A classification which has a growing tendency is that which consists of counting as two wagons those whose maximum load is 20 t. at least.

(3) This coefficient was determined in the following way :

Flat. — The mean length of 10 t. flat wagons being L for the general stock; and L' for a given railway, the value expressed in vehicle-unit *p'* for this railway is :

$$p' = \frac{L'}{L}.$$

Covered. — The mean length of 10 t. covered wagons being E for the general stock, E' for a given railway, the value in vehicle-units *c'* for this railways is :

$$c' = \frac{E'}{E}.$$

Open trucks. — The mean loading of open trucks of a given railway being 10 t. + *a*, the value in vehicle-units *t'* for the line under consideration is $t' = 1 + 0.075 \times a$.

(1) It is evidently this which caused it to be adopted by the R. I. V. « Convention ».

the extreme capacities of the wagons and the proportion of those of very large capacity increases ; it gives in fact the same hiring value to vehicles which differ as much in their cost price as in the tonnage they are capable of carrying. It is therefore no longer acceptable, except for the settling of interchanges between companies whose rolling stock is about equally balanced as regards types of wagons and the proportionate distribution of the total stock between the various types and when the interchange « convention » provides a time allowance for the return of each wagon considered separately. Even in this case it is to be feared that the receiving line would willingly keep, even at the risk of a penalty charge, the large capacity wagons of the delivering line, and this consideration is such as to induce the owning railway to prefer using these wagons for interior transport, in spite of the advantage they have for long distance transport. This explains the reason of the marked tendency to abandon the unit « wagon » which has been advanced at certain « conventions ».

§ 5.

HIRE AND PENALTY CHARGES.

Interchange « conventions » have nearly all made provision (1) for three kinds of charges :

Charges for hire;

Demurrage charges;

Penalties for misuse of the stock.

To these arrangements, others are occasionally added of a different character.

A. — Charges for hire.

In principle, the object of this charge is to cover the owning administration for the costs corresponding to the stay of its wagon on the receiving line (interest on capital, upkeep, sinking fund). A portion of these expenses depends exclusively on the length of time the stock is absent from the owning line (interest on capital, for instance) ; another portion depends on the contrary on the mileage, to which certain upkeep and sinking fund costs are proportional. The charge for hire ought therefore logically to be the sum of two terms, one of which is proportional to the duration of the stay on the receiving line, and the other should, if not proportional to the mileage run on another company's line, at least increase with it. In reality, a formula like this does not exist except in the type of « convention » of the Belgian Light Railways (1), the regulations of the International Union, those of the German Union, in the « conventions » which the Scandinavian countries have amongst themselves (2), and in a few « conventions » between lines of the Iberian Peninsular; generally the charge is dependent on the distance run or on the days the wagon is used.

(1) In France and Italy, certain « conventions » between a large line and one of local interest, only specify a charge for use. This occurs in the « convention » of the Swiss Rolling Stock Association, except for wagons constructed for special transport. The « South African Railways and Harbours » confine themselves to increasing by a fortieth of a penny per t. and per h., the hire of wagons when away from the owing line for more than a month.

(1) Certain light railway companies have abandoned this method in favour of the typical « convention » in specifying the duration of stay as the only basis for utilisation charges (see further on)

(2) And also for internal traffic in Denmark.

1° *Mileage.*

The system of charging exclusively by mileage is used by the Swiss Railway Association and by the Portuguese railways, together with the lines of Madrid-Caceres-Portugal and the Beira-Alta.

In France, including Colonies, it is no longer used, except by the Paris-Lyons-Mediterranean Railway for their Algerian lines.

Charges based on mileage are proportional to the distance run, except that formerly in Great Britain where for certain classes of wagons it was fixed according to a scale per mile which decreased as the length of the journey increased.

2° *Duration of stay.*

This system is used in Spain, France, India, Italy, Portugal and in Sweden for nearly all the internal traffic in these countries, and has been adopted in the R. I. V. « Convention ». The Belgian Light Railways, after forty-eight hours, make an extra daily charge, in addition to the kilometric charges (3). The R. I. V. « Convention » which provides for a daily charge is also likely to take the place of the V. W. U. and I. W. R. and certain agreements between individual companies which stipulate a mileage charge to which may or may not be added a charge for demurrage.

The time a wagon is out of the owning line is generally calculated in days; certain administrations however charge per half day and even per hour.

3° *Comparison of the two bases of charging.*

The information gathered during our enquiry shews a marked tendency to abandon the first system and extend the second one. Thus interchange agreements between the French administrations, since 1899, have made a charge per day, although previously the charge was based on mileage only.

In 1902, the Spanish railways ceased to charge mileage on account of the difficulty and amount of work necessary to find out particulars of the route-followed by each wagon.

The Paris-Lyons-Mediterranean Company have abandoned it in working with the Italian railways, but are continuing to employ it with the Swiss railways until the R. I. V. « Convention » is in operation. They are therefore in a good position to make a comparison between the two systems, and are of the opinion that charging by the day is simpler to apply and in addition proportionates better the charges for the services rendered by the receiving railway to the forwarding line.

The French Nord Company, which charges by mileage (1) for its interchange regulated by the International Union, considers that it is not so practical or simple as to charge on time, as it does not encourage, like the latter system, the receiving line to return as quickly as possible the foreign rolling stock which is sent to it.

The Belgian State Railways, which make use of the three systems (charging for mileage only, charging for time only and the combination of the two charges), consider that in principle the system of combination of mileage and time is excellent, because it takes into account at the same time the mileage and the time, but they recognise that on account of the constant increasing of interchange of rolling stock its application has become

(3) With exceptions given later on.

(1) Added to the charge for time.

very complicated. They add that the system of exclusively charging on mileage offers few inducements for punctuality, and necessitates moreover a considerable amount of work; they conclude by saying « Our preference leans rather towards charging by time only ».

Finally, the Belgian National Company of Light Railways, the type of « convention » which adds a daily charge to the mileage charge, states that the system which is recognised as good when interchange takes place between lines of about equal length, is inconvenient when the length of the railways differ materially. In the first case, the charge on mileage is sufficient; in the second, however, interchange is not always effected under the conditions arranged by the « convention ». It has therefore agreed to some of its associated lines charging by time, in spite of its « convention ».

To these various remarks, it may be added that the very principle of a charge based solely on mileage is open to criticism, for the length of the journey the wagon is used is not the only factor in considering what the owner should be paid. Another factor is the distance which a company may sometimes have to haul a wagon empty before it gets to the point at which it is going to receive the load. It is doubtless because of the difficulty in checking, that the method is only adopted by a small number of « conventions » (1).

Finally, the system of charging on mileage is inconvenient in the following ways :

1° From the point of view of the efficiency of the rolling stock by allowing the wagon to be at the disposal of the receiving railway on a mileage rating for a certain number of days which the latter has no interest in reducing;

2° The average mileage run by a wagon may or may not be the same on one line as on another and the period required for the journey may differ materially on account of the working arrangements, gradients, stopping points, etc., and the effect of these differing circumstances would make the period allowed for the return of the wagon to the owning company quite insufficient to avoid penalty, whilst in another case it might be ample.

In short, of all those countries with which our enquiry has been dealing, only Algeria, Belgium and Switzerland adhere in their interior working to the system of exclusively charging on mileage.

4° *Rates charged for hire.*

The question may be asked whether it is desirable to absolutely fix the charges for hire which have to be added to the expenses due to repair, interest, etc., which the owning company incur whilst its wagons are on the receiving line. The great variety of rates which were applied before 1914, that is to say, before the circumstances mentioned at the beginning of this report made these figures lose their significance, though partly due to a difference in the amount of those expenses taking one country with another, shew to what extent the administrations interested may vary their methods of dealing with the matter, dependent on the interpretation they place on the originators of the « conventions ». Thus, as regards the charge per day the following rates were current in 1913-1914 :

Belgian State and Belgian Nord: 1 fr. 05 per wagon of not more than 6 wheels;

(1) « Conventions » between the Paris-Lyons-Mediterranean Algerian system with the Est; « convention » between Spanish railways.

Spanish railways : 2 fr.;
French railways : 0 fr. 75 to 1 fr. 80 (1);
Indian railways (broad gauge): 3 fr. 84; (narrow gauge) : 1 fr. 92;
Italian railways : 0 fr. 10 per hour, *i. e.*, 2 fr. 40 per day;
Portuguese railways : 2 fr. to 2 fr. 50 per day.

The lowest rate was that of 0 fr. 75 as agreed to by the most recent French « conventions » of the time (Midi-Paris-Orleans in 1906, Paris-Lyons-Mediterranean-Paris-Orleans in 1908, Midi-Paris-Lyons-Mediterranean in 1913).

The general adoption of relatively low rates was intended to encourage the receiving administrations to look upon the return of the wagon as of secondary importance as compared with using it on its return journey. This is in fact the principle put forward in 1890 by Mr. Hanrez, Chief Engineer of the Running Department of the Belgian « Grand Central » Railway, a principle which was also adopted by Mr. de Richter in his report to the Congress in 1892 in the following terms : « The best system of interchange with a view of using the rolling stock to the best advantage is to avoid as much as possible transport of wagons empty ».

Whatever may be the case, it may be considered that the maximum hiring out value of the wagons is represented in normal times by the charge made for them to administrations and private firms by the companies which let out railway stock on hire. This charge includes, in addition to the actual cost, the profit which they legitimately make from the operation. This charge varied before the war in Belgium, France and Italy between 1 fr. 25 and 2 fr. 80, according to the time of the year and the class of wagon.

(1) This rate is now fixed on the typical unit of each of the three classes : flat, covered and open.

B, — Demurrage charges.

Of all the problems that arise relating to the question of interchange of stock, that of rating and demurrage is perhaps the most important, because on it largely depends the line which will be taken by the receiving road in using the empty stock on its return journey. If the rates are too low, there will be a tendency by the administrations to use the foreign stock unfairly, during periods of heavy traffic, when their own stock is for the time being insufficient. It is not always feasible for the administration which suffers to retaliate by also keeping back foreign stock; the direction of the flow of traffic has a preponderating influence in such cases, and of the two administrations, the one with the least freight — and consequently fewest wagons — to transmit to the other is naturally placed in a more favourable position. It can profit by it so as not to increase its rolling stock beyond its requirements for its minimum traffic and so avoid the purchase of new stock, cost of upkeep, sinking fund, and the necessity of finding accommodation for stock which it only requires for a portion of the year. If on the contrary the demurrage is too high, it is to the interest of the receiving administration to return the foreign wagons as soon as possible, even if it has to go to the expense of forwarding them empty and paying indemnities to consignors for delay in forwarding traffic. In such a case both the contracting administrations are obliged, on account of the moderate earning power of the interchange stock, to increase their total rolling stock beyond the limit really

justified by the total of their united requirements; in this way expenses are incurred which might have been avoided with an interchange « convention » better thought out.

The conditions appertaining to the application of demurrage play a part that is quite as important. In fact if the demurrage is applied to each wagon taken separately — and this was the case with nearly all « conventions » made in the last century — the receiving railway is induced for instance to send back a wagon concerning which the time allowed for its return has nearly expired, when by keeping it a day or two longer it could send it back loaded to the owning company. On the same day it might have, at some other point, a wagon belonging to this same company, for which it has still in hand, some of the time allowed before having to return it, but for which it has no use on the spot and may have to send it to the same point from which the first wagon mentioned left empty. This example is sufficient to show how illogical it is to apply individual penalties, and to explain why in new « conventions » it has become more and more the custom to fix demurrage for delay that is based on other considerations than the length of absence of each wagon *considered separately*. The length of its stay, beyond which the demurrage begins to be applied, is also an important point, because it is evident that too short a time will prevent the best use being made of it for its return journey, but if the time allowed is too long, the wagons may be used for their own purpose by the receiving railway. Finally, whether the demurrage shall be permanent, or on the contrary limited to those periods when the forwarding company is desirous of disposing of its rolling stock, the receiving line will have more or less interest in slack times to return the foreign stock quickly without making use of it.

We will now give a summary of the clauses of the principal « conventions » in force which bear on this essential aspect of the problem of interchange of rolling stock (1).

a) *Regulations of the International Union for the interchange of rolling stock.*

This « convention » regulates important international relations in the North West of Continental Europe.

The administrations reciprocally agree to help each other in the working of mixed or international transport in case of pressing need for rolling stock, by supplying such wagons as may be required.

The time allowed for the use of rolling stock is made up of that due to mileage and detention; the charges made for the regular use of stock are made up of mileage rates and rates for time; to these is added charge for late return when the time allowed has been exceeded.

Exemptions for charges on time and the charge for delay in returning the stock are accorded in certain cases in order to encourage the rapid unloading of the wagons, so that they may be used over again, or on taking into account circumstances independent of the control of the staff of the receiving railway (customs routine, serious damage to stock, congestion of traffic).

Other international conventions are in operation which do not vary much, as far as these various points are concerned, from the one we have just dealt with. They are those we have already mentioned, *viz.*, those which operate on the Scandinavian railways either

(1) In order to make the summaries intelligible, the details of a few clauses have been included which do not strictly belong to the subject dealt with in this paragraph.

in their international relations between one another, or in their relations with the railways in the German Union (1). We are purposely leaving on one side the « conventions » which are intended to be replaced by the proposed R. I. V. « Convention » (2) which will be dealt with later on.

Besides international arrangements, the type of « convention » which arranges for a separate settling of accounts for each wagon is used, though in a diminishing degree between certain lines in the same country; such is the case in the « conventions » between the various lines which form the Belgian National Company of Light Railways, the « conventions » between certain Portuguese lines, « conventions » between the great French or Italian railways and certain local lines with standard gauge (see § 7 further on for the latter), etc.

All these « conventions » arrange for an individual debit account against each wagon. The only advantages which accrue from this method of dealing with the matter make the time the wagon is away from the owning line as short as possible, and — in theory at all events — to make the payment for its use as equitable as possible. The first of these has a special importance when the wagons of two administrations are of markedly different types, peculiarly adapted to the requirements of the owning railways. This may explain why this kind of « convention » has been more particularly adopted for international arrangements, as well as for agreements between large railway systems and those of a local character. Charging rates made up of two items (mileage and time) however offer on the other hand serious difficulties : primarily from the point of view of the reasonable use of the rolling stock. The penalty charge being applied in fact to each wagon separately, the receiving administration is induced for instance to send back empty a wagon that might be utilised at a station A, but on which the time allowed for returning it is about to expire, although by keeping it back for a day or two days at the most A could load it and return it to the forwarding line instead of having to use a wagon belonging to its own system. On the same day the receiving line may have at another point B a wagon belonging to the forwarding line, on which the time allowed has not yet expired, and so there being no return load for it in the vicinity, it has also to be returned empty, whilst the use of a wagon of the receiving line might have been avoided as between the departure point B and destination on the delivering company's line.

Another inconvenience arises from the complication caused by having to keep an individual account for each wagon.

b) *Spain : « Convention » between the Northern and Madrid Saragossa and Alicante Railways.*

Similar « conventions » have been arranged between other lines of the Iberian Peninsular (Spain and Portugal), generally one Spanish line with one Portuguese line (1). They are essentially based on the equal running of wagons of one company on the line of the other railway, and provide, in cases where this does not balance, that the company having the largest number of wagons running on the other line is credited at the following rates per day

(1) The regulations of the German Union equally apply to the relations of the Dutch and Swiss railways with the railways comprised in this Union.

(2) In particular, the regulations of the German Italian Union (I. W. R.).

(1) This is the only example brought to our knowledge, of an international « convention » being in force without individual regulations applying to each wagon.

and per wagon of every kind including those of other companies (1)

From 1 to 600 wagons	2 pesetas.
Above 600 wagons	5 pesetas.

Reduction of the balance of rolling stock.

When one of the two contracting companies has an excess of more than 600 wagons running on the other company's lines and it wishes to reduce the balance to the latter figure, it may decide that the junction stations shall forward on to its lines all its own wagons coming from the other company, whatever may be their load or destination; moreover it will unload at the cost and risk of the other company those wagons which are intended for it, unless the latter gives up a sufficient number of empty wagons to bring the balance to within normal limits.

The first of these will only be enforced after a delay of forty eight hours counted from the time notice was given to the authorities concerned; this time allowance is increased by five days when it is proposed to put the second of these regulations into operation.

Stopping of the rolling stock on account of interruption in service or from any other cause.

In such case, the said wagons are excluded from the daily balance as long as they cannot be moved, but on condition that the company in whose care they are advises the owning company of what has happened within eight days. When it concerns wagons received from a third company, an additional eight days is allowed for forwarding the advice to each company over which the vehicle must pass to reach the owning company.

Returning stock.

Arrangements are made for this purpose sometimes at any joint station, sometimes by the station where the consignment was delivered, and sometimes at certain junction stations where arrangements are made to hand over the same number of wagons as have been received.

(1) The figures vary from one « convention » to another. Those reproduced are those in the convention referred to at the head of the paragraph.

Such are the essential points in the type of « convention » used in Spain and in a certain measure also in Portugal. The charasteristics of this type are as follows :

No consideration is given to what may happen to any particular wagon, except that in certain cases it may be asked that it shall return through the station it entered at or through other junction stations that have been decided on; it satisfies the desire that the interchange use of wagons should be equal on each system. If the limit fixed is exceeded, a pecuniary penalty follows automatically on account of the charges made on the day-wagon system, the company suffering the loss, however, has three other methods of reducing the seriousness of the break in equal interchange, *viz.*, keeping back all the wagons belonging to the other company whatever may be their loading or destination; unloading at the cost and risks of the other company the wagons destined for the latter, and obtaining from the defaulting company a consignment of empty stock.

These regulations in their original wording have been in force about fifteen years, showing that they are sufficiently comprehensive to meet the requirements of the participating railways.

c) *Rules of the « Indian Railway Conference » (Association for the interchange of through traffic between the railways of British India adhering to this Association).*

The actual text was put into force the 1 January 1913 (1), and begins by stating that the

(1) It was however completed the 1 January 1921, by means of an appendix applicable to some of the railways forming part of the I. R. C. A., and which will be dealt with later on.

railway on which the traffic originates shall supply the wagons necessary for such traffic. At the same time if the forwarding railway has an excess of not less than 5 % of its total goods stock or of 600 wagons (whichever is less), on the receiving railway it may call upon the latter to supply at each junction as many wagons as it considers necessary to reduce the outstanding balance to not less than 3 % of its total effective stock or to 400 wagons at the maximum (in taking as basis the lesser of these two figures) and to maintain it at that limit. If the call has not been complied with within ten days of its receipt and if the balance in excess is not maintained within the limit required under the call, the receiving line must pay on and from the eleventh day, for the daily outstanding in excess of the unpenalised balance an enhanced rate of hire as follows :

1° Double the ordinary rate of hire for every wagon in excess over the unpenalised balance when the outstanding balance is equal to or less than that which was the cause of the call;

2° Four times the ordinary rate of hire for each wagon on the total excess over the unpenalised balance when the outstanding balance is more than the calling balance.

The receiving railway may, however, satisfy the demand for balancing the stock by sending either empty or loaded wagons, but the parent line may refuse to receive empty open wagons other than its own in lieu of covered wagons and *vice-versa;* it may also refuse to accept empty wagons at any junction after the outstanding balance at that junction has been cleared off. The excess wagon balance is calculated on the total daily balance at all junctions of lines of the same gauge between the two railways.

The receiving railway is on its side allowed to claim credit for the loss in equilibrium when the outstanding balance against it is at least 5 % of the total goods stock of the forwarding line (or 600 wagons), and call on the forwarding line, after giving seventy-two hours notice to take over a sufficient number of wagons to reduce the outstanding balance to a number not less than 3 % (or to 400 wagons); these wagons must not be returned to the receiving railway unless loaded, or when the outstanding balance has been reduced to the fixed maximum (3 % or 400 wagons).

To sum up, the « convention » which regulates the interchange of rolling stock between the greater part of the railways in British India has the following characteristics :

The delivering line has in connection with the use of its stock on the return journey rights which practically limit the length of absence of any particular wagon.

The interchange account starts, as in *b*, from the time a call is made for equalisation between the number of wagons forwarded by each railway to the other, but with this essential difference, *viz.*, that the pecuniary penalty does not act automatically solely because of the importance of the lack of balance in wagons. In order that this penalty may come into operation, it is necessary that : 1° the forwarding line must have asked the receiving line for the supply which it, as consignor, judges necessary to adjust the loss in balance and to maintain it below a certain limit; 2° if this call is not satisfied within the ten days, the penalty comes into operation, under the form of an enhanced rate of hire, commencing on and from the eleventh day, of double or quadruple the ordinary rate, according to the excess of the outstanding balance.

On the other hand, the line in default has the right to adjust the balance if it has more wagons than it requires by calling upon the other railway to take them over to bring the balance down.

These formulæ are much more elactic than those of type *b*, since on the one hand the penalties do not come into

operation until the forwarding railway requires the stock, and on the other hand, the line having an outstanding balance can either continue to use the forwarding company's stock at the lower rate, or adjust the difference by handing over a number of wagons and so bring the outstanding balance below a certain limit.

Quite recently (1 January 1921) certain railways belonging to the « Indian Railway Conference Association » decided, as an experiment, to suspend, as regards their wide gauge lines, the application of the rules just explained, having decided to use their rolling stock in common. The essential conditions of this « convention » are as follows :

Unless prohibited by the Director of Wagon Interchange, the wagons will be available for indiscriminate loading to any station. They should, however, be loaded to the owning railway whenever practicable.

The ordinary rate for daily hire is fixed at 4 rupees 4 annas. The payments for hire which are made to — or by — a line are determined by the net balance in favour of or against that railway as ascertained from the balances at all its junctions with any other railway.

The Director of Wagon Interchange has full power to call upon a railway to make over to the other railway at junctions of interchange as much stock as is necessary to reduce its net balance to zero, but shall not, except in very special circumstances, call upon this railway to make over more than this number.

Any railway which has stock in excess of its requirements shall inform the Director, who will at once issue orders for its disposal amongst those railways that require stock, or use it to bring the balance of other railways to zero. Should the balance on the railway having excess stock not be above zero, it shall be within the power of the Director to move the excess wagons if he thinks fit.

d) *Rules for operating goods rolling stock on the French railways.*

General principles (1).

The railway companies, while admitting in principle that each one of them should be able to use the rolling stock which belongs to it on its own lines, have initiated a working arrangement for the common use of the goods rolling stock belonging to them or at their disposal, basing this scheme on the following principles :

1° A common account is kept for the use of the wagons;

2° Each railway should, in principle, have at its disposition each day a number of vehicle-units (2) approximately equal to its stock of vehicle-units, as will be explained later on.

Central control.

A central organization called « Office central du mouvement des wagons » deals with

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(1) The programme drawn up by the managers of the main French lines for the committee who reported on the « convention » was a follows :

« The *maximum efficiency* of the rolling stock should be ascertained; at the same time it is necessary for the wagons to return to the parent line if only to make certain they are kept in a good state of repair; further, each line adopting more or less the types of stock most suitable for its class of traffic would not be satisfied by receiving another kind of stock, though of equivalent capacity.

« It is necessary that *the use it may be put to should be paid for at its true value* and that each railway should have the same interest in constructing wagons, as is the case with the stock of an independent railway. This is the essential point. The daily rate of hire should therefore be based, not on the value of the existing stock, but on the price of that which has to be ordered; in addition each railway must at periods of heavy traffic be able to have at its disposal *in kind* whatever it may possess; it is not sufficient to credit it with hire of wagons whilst the supply it has is insufficient at such a time. »

(2) See chapter II, § 4 of the present report for the definition of vehicle-units and classes of vehicles.

the interchange of vehicles used in common between the contracting railways, and settles for each day and for each class of vehicle the vehicle-units to be handed over by each railway into the general stock, and what is really available for each one of them.

Contribution given by each railway.

The contribution given by each railway includes (1) :

1° The number of vehicle-units from its own stock delivered each day into the general stock;

2° If necessary, the number, positive or negative, of vehicle--units corresponding to the difference between the number of vehicles received from non-participating administrations and that of the vehicles which have been forwarded on to them.

Stock available on each railway.

The stock available on each railway is taken as the vehicle-units that are running on each one of them each day. If on account of the railway, to which the consignment is sent or is in transit, being unable to receive the traffic, the vehicles have to stand on the lines of another railway, the corresponding vehicle-units are looked upon as stock available for the railway which is responsible for this.

Interchange account of stock with foreign lines.

The Central Control Office draws up and settles the accounts for hiring of the whole of the participating lines, for the stock interchanged with foreign lines in accordance with the « conventions » in force.

In order to allocate to the different participating lines the debits or credits resulting from these interchanges, a special account is kept by the Central Control Office called « Interchange account of stock with foreign railways ».

To this account is carried the difference between the total debits and credits of the financial accounts of the various participating railways; if this difference is positive (that is to say if the debits outbalance the credits) it constitutes a credit for the said account, and if the contrary is the case, it is a debit. The account is also credited or debited with the amounts in the books of the Central Office at the time of the periodic settlements of the interchanges between lines of foreign nations.

The credit or debit balance of this account is divided between the various participating railways proportionally to the available stock credited to each one of them during the corresponding period.

Joint stock.

A central organization called « Office centual property of each line, the participating railways have contributed to the general stock a certain number of vehicles which belong to no single one of them and are called the « Joint stock », a special account for these being kept in the Central Office.

In order to apply the preceding arrangements, the vehicles belonging to this stock are dealt with as if they belonged to a special participating line, but the vehicle-unit accounts include them as contributory stock and not as available stock. The Central Control keeps a working account of the joint stock, which is credited with its credit balances and hiring accounts, and is debited with costs of storage, upkeep, sinking fund and other yearly expenses which concern the vehicles forming the joint stock. Losses or profits are divided annually between the various participating lines proportionally to the totals of the available stock of each one of them during the period of joint working.

Special arrangements.

Each participating line has right to the daily use of a number of vehicle-units representing its share in the Association.

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(1) This contribution is calculated separately for each class of vehicle. Generally all which relates to book-keeping and distribution is subject to separate enquiries, permits and accounts for the various classes of stock, although no mention may have been made of this in the comments on the « convention », this being done in order to simplify the report of the committee.

When for a period of eight consecutive days, the amount of available stock in vehicle-units on the lines of a participating railway has been less than its own share by more than 10 % (1) of this share, it is allowed to ignore the restriction according to it the use of other companies' wagons and has a right to request that steps be taken to supply it with the stock it requires.

The same rule applies when during a period of thirty consecutive days, the available stock of the line on each day has been below its own share by more than 2 %.

Moreover, when during the whole of a period of fifteen consecutive days the total of the real available stock in vehicle-units is found on a participating line to be below its share by more than 10 % (1) of this share, this line has the right to request and obtain a credit equal to half the customary rates (2) for the number of day-vehicles representing the difference between its share and the total of that which it has had the use of. This credit will cease if, after a period of fifteen consecutive days, the total available stock has reached a number at least equal to the figure corresponding to the share belonging to that line for the said period. This will be charged as a debit against the lines which show an excess of vehicle-days of which they have had the benefit relatively to their own share, and the cost will be divided between them proportionately to this excess.

Reciprocally, when for the whole of a period of fifteen consecutive days the total of available stock in vehicle-units found on a participating line has exceeded the latter's own share by more than 10 % of its share, this line will pay, unless a contrary decision is given by the majority of the other participating lines, an amount equal to the value of half the customary charges for the number of vehicle-days representing the difference between the total of which it has had the use, and its share. This payment will cease under the conditions mentioned above in the reciprocal case. The proceeds will be divided between the lines which show a deficit account of vehicle-days of which they have had the use relatively to the corresponding figure representing their share, proportionately to this deficit.

The two rules set out in the three preceding paragraphs may be applied simultaneously.

It results from the preceding summary that consideration of the equalisation of interchange serves as a basis for the « convention » between French lines similarly to the « conventions » dealt in *a* and *b* above, but there are important differences between the two.

The chief feature of the « convention » consists in the way in which a lack of balance is dealt with. In the first place, this is not, as in the cases *b* and *c*, calculated for the relation between each pair of railways, but for each line in its relation to the whole of the others combined. In addition, a certain number of wagons are put into common use as « joint stock ». On the other hand, the interchange of wagons with the lines of other countries, while being subject to an account kept between the French and foreign railways interested is dealt with by a distribution being made of the balance of these accounts between the combination of French railways. Finally — and here the « convention » resembles that of type *b* — when the balance is upset beyond a certain point, a company which has on its lines less than its share is allowed to use without restriction the stock of the other companies, to request that its own wagons be returned, and when the lack of the balance continues beyond a certain length of time, to claim credit proportional to the number of vehicle-days representing the difference between its share and the total it has had

(1) This rate will be authoritatively revised with the object of reducing it, as it will be recognised that working conditions of the « Office Central du mouvement des wagons » are normal.

(2) Actually this rate is fixed for the unit-type of each of the three classes, flat, covered and open.

the use of. Inversely, a line which has more than its share must hand over, except otherwise decided by the participating lines, an amount proportional to its excess in wagons. In both cases the payment is carried to the common account to be divided between the lines which show a surplus in the first case and a deficit in the second.

The adoption of this system, which only dates from 1 April 1920, is still too recent to enable us to draw any comparison between its advantages or disadvantages.

e) *Convention between the Swiss Railways for the common use of goods rolling stock.*

Method of using the stock.

The basis of the « convention » lies in pooling stock. All stations belonging to the contracting administrations may utilise this stock put to common use; at the same time, when they have the choice and when there is no trouble in so doing, it is, however, looked upon as a rule that the stock should be loaded so as to travel in the direction of the owning line wherever possible.

Wagons constructed for special freight are excluded from common use; they must be returned within a specified time, in default of which a charge is made for each day's delay.

Distributing offices.

A certain number of distributing offices as well as a central office deal with the distribution of goods stocks according to the requirements of the stations.

The amounts paid on account of late delivery of stock are placed in a common account and divided amongst the various contracting administrations in proportion to the mileage run by their stock to the total mileage of that pooled. The same procedure is followed when, owing to shortness of the pooled stock, foreign stock is used.

Conditions under which wagons may be used.

If, on account of physical conditions (strength of bridges, loading gauges, etc.) on the lines of foreign administrations, transhipping of the contents of the wagons becomes necessary, the costs of this transhipping must be borne by all the Swiss companies having an interest in the conveyance of these wagons and divided up « prorata » according to the mileage they have run loaded on each line.

Responsibility.

If the wagons of the contracting companies sent on to foreign lines are not returned, the resulting loss will be carried to the common account, so far as it has not been covered by a third party, and will be divided in proportion of the mileage of the stock of each one of them to the mileage of the pooled stock during the year the wagon was away.

Allowance for mileage and hire.

Each administration on the lines of which a wagon belonging to the associated companies runs, pays to the owning company an allowance of one centime per axle per kilometre. The demurrage received from customers at stations for delay in loading, unloading or returning the wagons belonging to the pool, are allotted to the company which has conveyed the wagons.

The interchange accounts are made out from the returns received from the stations and the « Running of rolling stock » sheets.

Balancing account.

At the end of a financial year, the final balancing account of the association is made out according to the following arrangements :

a) Each administration pays in to the pool account the amount received from the total mileage on the lines of the contracting companies and on those of other railways in Switzerland and outside, of the wagons it has supplied to the common stock including the mileage run on its own lines, at the rate of 0 c. 4 per km. and per axle;

b) To each contracting company is allocated

its share of the resulting amount which is due to it in the division of the above mentioned receipts « prorata » to the number of wagons supplied to the pooled stock by each one of them, covered wagons being reckoned 20 % more than open wagons.

The « convention », the summary of which we have just given, differs in nearly every respect from the other « conventions » by which two or more companies have to a greater or lesser extent pooled their rolling stock. The principal points which are not found in any other « convention » are as follows :

Penalties incurred on account of the late delivery of stock and use of foreign stock in case of a shortness in pooled stock are charged to the common account.

Certain transhipments and certain losses on wagons forwarded to foreign lines are charged to the common account.

Payment to the owning company by the company using the vehicle of a mileage allowance, the owning company, however, putting into the common pool at the end of the year an amount that is proportional to the total mileage of its own vehicles.

Distribution of the net receipts from the common funds, between the contracting companies, « prorata » to the number of wagons they have respectively supplied to the common stock.

This « convention » has been in operation since 1887 without any appreciable alterations being made to it, from which it would seem that it may be considered that up to the present it has given complete satisfaction to the companies using it. At the same time it may be asked if, owing to the increase in the cost of wagons that has taken place during the last few years, the rate of remuneration provided for is not now too low to induce the companies to increase their rolling stock, there being no clause in the convention to force them to do so when traffic demands this.

f) *Regulations known as the « C. I. V. » for the interchange and reciprocal use of vehicles in international traffic.*

This convention, which is only under consideration at the present moment (September 1921), is almost a copy as far as general details are concerned, of the German Italian Union (I. W. R.) regulations which it will replace, but differs in certain essential points, one being an important improvement which has been added dealing with the conditions relating to the use of foreign stock, by the receiving railway on the one hand, and fixing the interchange account on the other. The rules regulating these two points are as follows :

The charge for the use of the stock is limited to a charge on time, whilst the I. W. R. stipulates for a charge on mileage and in addition a charge on time.

In addition, the charges on time are calculated per whole day and per wagon and are fixed as follows :

2 fr. 50 for each of the 3 first days;
3 fr. for the 4th, 5th, 6th and 7th days;
4 fr. for the 8th, 9th, and 10th days;
5 fr. for the 11th, 12th, 13th, 14th, and 15th days;
6 fr. for over 15 days.

These charges are not applied to privately owned wagons.

The characteristics peculiar to this formula are in the first place the abolition of all consideration of distance and special circumstances (customs, Sundays and fete days, conditions relating to re-utilisation, etc.), in determining the starting point for the application of the penalty charge, by fixing a daily rate which is increased from the beginning of the 4th day, then in fixing a charge for hire

which increases daily after the third day up to the 16th.

Arranged on this basis, the accounts will be materially easier to make up than with those of the other International Conventions and so will escape the criticisms raised under the following heading « C » against individual regulations. It may be asked, however, if outside the above advantage this scheme, which is about to be tried, will not induce the receiving lines — more particularly those on which, owing to their size, certain journeys there and back will take more than three days — to send back empty vehicles which should in the general interest be used on the return journey.

g) *Conventions in which the stock is simply pooled without any charge being made for its use.*

According to the replies received, this system is made use of at least in the three following cases :

a) Interchange between the « South African Railways and Harbours » on the one hand, and the « New Cape Central Railways » and the Lourenco-Marques Railway Company on the other. It should be pointed out that the latter's stock (930 wagons) is of small importance in comparison with the S. A. R. (28 000 wagons). We have not been supplied with the corresponding information by the N. C. C. Railways;

b) Interchanges between the various Dutch Railways : Netherlands State Railways (S. S.), Holland Railway (H. S. M.), Central Netherlands Railway (N. C. S.) and North-Brabant-German Railway (N. B. D. G.). The pooling applies also to sheets and other loose fittings;

c) The railways of Great Britain which before the war had a common convention (Rules of the « Railway Clearing House ») based on the principle of individual regulations for each wagon, and who abandoned this system, for the time being at least, when the Government of Great Britain, on the outbreak of war, took into its hands the almost absolute control of the British Railways.

In January 1917, all the controlled railways adopted a method of pooling, which was at first limited to sheets and open wagons, and afterwards included ropes and covered wagons. Under these new rules each participating company may use the stock belonging to the pool as if it were its own. The question of the continuation or the modification of the rules put into force during the Government control of the railways was still being considered at the date when our questionnaire was replied to (January 1921).

C. — Fixing the time from which charge for demurrage is made.

In the recent conventions we have just analysed, it is particularly simple and easy to determine this, it being only necessary to know either the daily interchange balances at the various junction points, or the number of days the stock of the delivering line has remained on the receiving line. It is not the same however when each wagon is liable to be penalised individually; in this case it is evidently necessary to fix the length of time required to accomplish the various operations it has to execute — transport on the outward journey, customs formalities, unloading, disinfection, reloading, transport on the return journey — and to closely follow the successive stages of the wagon from hour to hour. Generally the total detention is increased by Sundays and fete days which occur during its journey; this addition is only taken into account when the Sundays or fete days happen to occur on the days that were fixed for unloading or loading.

The International Union's Regulations allow a deduction to be made for the Day of Repentance and Good Friday in Germany, and for Shrove Tuesday and the Assumption in France and Belgium. It

is easy to see what complications the application of such close rules give rise to in drawing up the interchange accounts, and the interest a certain number of administrations have in adopting new rules for regulating interchange, which, in addition to their advantages as regards increasing the efficiency of the rolling stock, have also that of making the penalty charges dependent on the actual situation of the whole of the interchanged wagons. By this latter method there is in fact no necessity to ascertain for each wagon any particular circumstance that might tend to increase the time it was on its journey, because anything of this nature would be compensated for in taking the interchange wagons as a whole, and it is sufficient in consequence to determine either the average stay allowed without a penalty charge, or the numerical extent of the wagons out of balance beyond which the penalty charges are applied. Only detention resulting from break-downs or cases that are unavoidable should be recorded and deducted (1), but these are relatively rare and accordingly do not appreciably complicate the drawing up of the interchange accounts.

D. — Various penalty charges.

Some conventions, in addition to demurrage, insist on penalty charges for the use and working of foreign wagons not in accordance with the rules.

The Regulations of the International Union stipulate penalties, as regards wagons returned empty in a wrong direction towards the owning line, and thereby profit those administrations who have unduly hauled the empty wagons.

1° The charges for use paid by them to the owning railway;

2° The same sum on account of hauling the wagon empty.

On the other hand, if in spite of the conditions stipulated for loading the stock on its return journey a wagon is reloaded for a station beyond the owning railway and situated on a line that has not been used for the outward journey, the journey which the wagon will be obliged to make empty in order to follow its usual route and return to the owning administration will bring into operation the penalties provided for in rules 1° and 2° above, at the cost of the administration responsible for the irregularity.

The latter will also be charged demurrage for each day beyond the time allowed for the journey in the proper direction.

The International Scandinavian Convention and that of the German Union, which are as far as this point is concerned a reproduction, stipulate that when on account of reloading a wagon for a station that was not passed through on the outward journey, the return journey has been increased by 200 km. (125 miles) above the outward journey, the administration responsible shall pay to the owning railway, for each kilometre of the journey beyond 200 km., a sum equal to six times the hiring charge.

In addition to the cases provided for in the preceding paragraph, each foreign wagon used contrary to the regulations provided for in the convention entails a payment to the owning company of 5 fr. per wagon per day for the use of the wagon contrary to the rules; this also applies in certain cases of irregular

(1) Generally under the condition that an advice is immediately sent to the forwarding line.

unloading of wagons in the course of their journey, or the handing back at a transit station not officially recognised, of empty or insufficiently loaded wagons.

Finally, if any empty or insufficiently loaded wagon is sent back to the owning railway over a route different from that taken when on its outward journey, the administration at fault must pay the conveying administration for the haulage of this wagon at the rate of six times the mileage charges relative to the distance covered by the empty or insufficiently loaded wagon.

The authors of the projected R. I. V. Convention have adopted a much simpler wording, confining themselves to stipulating that all use of foreign wagons contrary to the stipulations of the convention entails, for the administration at fault, a payment to the owning administration, of a fine of 40 fr. per wagon per day for each wagon that has been misused. This charge ceases when the wagon has been returned into the hands of the owning administration.

The Belgian Conventions stipulate a fixed fine of 50 fr. per wagon, in addition to what is due for the use of it, in case of the use of the stock of one line which has not been previously authorised for interior service on another line.

In certain Spanish Conventions it is stipulated that the company which detains or makes use of transhipped wagons shall pay to the other Company 10 fr. per wagon per day, this wagon, however, is entered in the daily balance account.

The regulations of the « Railway Clearing House » in force before the war provided, in case of wagons sent in wrong directions, for a penalty charge which was generally double that stipulated for any other kind of detention.

The regulations of the « Indian Railway Conference » stipulate that for sending in the wrong direction or for misuse, a fixed charge of 16 fr. per wagon, or double the hire charges shall be made, in addition to any other charges incurred under these regulations.

E. — Compensation in kind.

« Conventions » arranged on systems more or less similar to a pool generally provide that when the want of balance exceeds a certain number of wagons or a certain proportion of the stock of the line which is short of wagons (crediting line), the line which is benefitting thereby can be made to re-establish the balance by handing over a supply of empty stock (1). With the same object in view, certain « conventions » allow the line that is short of stock the right of demanding the handing over of its wagons in the junction station, and this at the cost of the line that has benefited (debiting line), at the same time allowing the wagons of the latter to pass through (2).

Inversely, the debiting line is allowed to request that the loss in balance shall be put right when the balance against it exceeds a certain limit (3).

Sometimes it is arranged that the crediting line shall not be expected to conform as long as the balance is upset, to the restrictions that apply to the stock in returning (4).

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(1) See above, in the analysis of the « conventions » between the Spanish railways, the rules of the « Indian Railway Conference » and of the « convention » between French lines.

(2) See above, in the analysis of the « conventions » between Spanish lines.

(3) See above, in the analysis of the Rules of the « Indian Railway Conference ».

(4) See above, the analysis of the convention between Spanish railways and the convention between French railways.

In the system of pooling now being tried on a certain number of broad gauge lines in British India, the director of the traffic has considerable authority and may order one of the participating lines to send along stock to another participating line.

Without giving an entirely satisfactory result, these various methods of balancing are of such a nature as to minimise, more efficaciously than by imposing pecuniary penalties, the seriousness of any lack of balance (dependent of course on the orders given for the supply of empty stock being promptly executed). These orders are in fact given by the central control to those districts where there is an excess of empty stock due to the predominence of incomings over outgoings; those who receive these orders gain no material advantage by evading them. Wagons on which pecuniary penalties are imposed are on the contrary distributed indiscriminately amongst all the stations which, if short of stock for their consignments, may be tempted to irregularly use a foreign wagon rather than return it empty.

At the same time, it is necessary to make a proviso as regards the method of handing over wagons coming from the crediting line, which is not very practical in its application, for if the debiting line abuses its position to keep wagons of the crediting line (in order to make up for its own shortage) it will be in need of stock for transhipping wagons that the latter has delivered loaded and consequently will have to leave them loaded — and so keep them idle without profit to anybody — as soon as there is an insufficiency of room in the goods sheds or wharves.

§ 6.

CONVEYANCE OF EMPTY STOCK.

A Company may have to forward empty stock to another line, either to pick up goods for its own use (fuel for instance), or to forward them on to other lines of its own system, or to another line situated beyond that to which the consignment was sent. Finally, certain administrations have mutually agreed to help one another in cases of shortness in stock.

The most interesting stipulations relating to these kinds of consignments are as follows :

Regulations of the International Union.

If wagons used by an administration for traffic over several railways or for international transport, run unloaded over an intermediate line either on the outward or return journey, or if they travel empty over an intermediate line, or if when empty they make use of a longer route of an intermediate line than that they travelled over loaded, the administration at fault must pay to the administrations which have incurred the empty mileage the charges mentioned in § 5, subsection D above for breaking the regulations. The use of borrowed wagons for purposes other than those for which they are designated by the owning railway entails the same penalties.

International Scandinavian Conventions and Regulations of the German Union.

If wagons requisitioned on loan for transport are not returned to the owning administration by the same route taken on the outward journey, or if they are sent back insufficiently loaded, the administration that requisitioned them is required to pay six times the customary charge for mileage to the intermediate administrations for the journeys made in one or other direction by the empty or insufficiently loaded wagon, deduction made for the distance travelled by the wagon when sufficiently loaded on the same line even when this has been accomplished on other lines.

As with the Regulations of the International Union, the charges for improper use of wagons apply equally to all empty wagons that are used for any other purpose than that allowed by the owning railway.

When an administration belonging to the Union hires wagons for any use it likes to put them to, it has to pay, during the period for which they are hired, mileage charges that are six times as great for these wagons if empty or insufficiently loaded both for the outward and the return journey.

R. I. V. Convention.

It differs little in this respect from the type of conventions we have just dealt with as regards the penalty charges imposed, which are uniformly fixed at 40 fr. per wagon per day for misuse, as explained above in § 5 under subsection « D ».

Conventions between the Spanish lines Nord-Madrid-Saragossa-Alicante and between the Italian State Railways and various secondary lines.

A charge for haulage is made by the line that is run over : it is stipulated that the journey shall be made as rapidly as possible, and that the wagons shall not be used under any pretext whatever by the line they have been handed over to, and that an indemnity consisting in a reduction of the charge for haulage shall be paid to the owning line in case of delay.

Indian Railway Conference.

A charge, fixed by mutual arrangement between the lines, is made for this kind of running, and wagons sent empty in order to bring back coal for the owning railway are only charged at half the usual hire rates.

§ 7.

INTERCHANGE BETWEEN MAIN RAILWAYS AND LOCAL LINES.

These interchanges are relatively of small inmportance, because a number of local light railways have a smaller gauge than the main railways with which they join up. They are most often the object of a special convention between the main and local lines in contact. Certain small railways in Great Britain have become parties to the regulations of the « Railway Clearing House », whilst in Switzerland local lines form part of the « Association suisse du matériel roulant ». In Belgium the running of State Railway stock on the light railways is subject to certain conditions of which the following are the chief :

The wagons must be returned within twenty-four hours, this time allowance is doubled for stock sent loaded to the light railway and used for a return load which must be at least a fifth of the registered loading capacity of the wagon.

A charge is made for the use of stock put at the disposal of the light railway based on hours per wagon, also in case of delay in the return of the stock, a charge is made on the same basis.

The stock can only be used for goods, the conveyance of which has been or will be carried out by the State Railway.

In case of damage, of whatever kind or cause, the light railway must pay the costs on presentation of the bill by the State Railway.

These special « conventions » do not materially differ, in the majority of their clauses, from the « conventions » between main lines which we have already investigated, it is only necessary to retain those clauses which concern them particularly, the object of some being to make the big line render assistance to the local line without reciprocity, whilst others are to simplify the drawing up the interchange accounts.

It is for this reason that the « conventions » of the Italian State Railways with various light railway companies stipulate that the State Railways (when, according to their judgment the requirements of their own traffic permit it) will supply empty wagons which the light railways

may require for consignments starting from their own stations and being worked over both systems. A similar arrangement exists in the convention between the railways of the French Midi and the Herault Railway Company.

The Convention of the French Midi Railway Company and the « Société des voies ferrées des Landes » stipulates that the latter railway, which has no goods rolling stock of its own, shall be supplied by the Midi Company in consideration of a very small daily charge for the first three days, but more than double for the four successing ones and nearly five times as much from the eighth day onwards.

The Conventions of this same « Company » with the « Société des chemins de fer des Pyrénées-Orientales » and with the lessee of the line from Luxey to Mont-de-Marsan, stipulate that the goods rolling stock of the light railway is to a certain extent for joint working with that of the main line. The latter credits the owning railway daily with the number of wagons of the local lines that it has in use, and debits it each day with the number of wagons that are in use on the local lines. This method of settling has the advantage of being very simple, since it avoids having to follow the routes the wagons of the local line take on their trips on the principal line. It also expedites their return to the owning line, and compels an account being kept of the length of their stay with a view of a charge being eventually made.

§ 8.

INTERCHANGE BETWEEN RAILWAYS HAVING DIFFERENT GAUGES.

Two cases have been brought to our notice, one is that of wagons sent by a forwarding agent for traffic between Paris and Portugal. On account of the difference of width between the French line and that of the Iberian Peninsular, the wagons in question are constructed in such a way that their axles may be rapidly changed when crossing the Franco-Spanish frontier. These wagons, however, belonging to a private owner do not necessitate an interchange account between the administrations participating in their transport.

The second case is that of interchanges between standard gauge and narrow gauge in Denmark and in Sweden. The narrow gauge wagons are loaded on special trucks of standard gauge. The convention which regulates the interchange between Swedish railways as regards their internal traffic provides as follows for the interchange of narrow gauge wagons.

The charges for the use of these special trucks are based on mutually arranged conventions which govern the relations between the companies. The Swedish Railway Company, with standard gauge, takes charge of the narrow gauge wagon as soon as it is placed on the special truck.

§ 9.

DAMAGE AND REPAIRS TO INTERCHANGE WAGONS.

The regulations, dealing with this subject differ more or less in the different conventions, but with the exception of a few details they agree with one or other of the types described below.

Technical Regulations of the International Union (governing the countries belonging to the International Union).

Where vehicles are found to be damaged when offered for interchange, but the damage is not serious enough to prevent their being

accepted, particulars of the damage are taken by both companies at the point of interchange, these records are the basis of claims for damaged stock, but account is only taken of those (except in certain cases specified in the regulations) which exceed 18 fr. 75 per vehicle.

Damage that has not been noted in this way at the transit station is charged to the administration on the lines on which the damage is noticed or has happened. It is understood however that the owning administration bears the cost of damages to axles, wheel centres and tyres, whatever may be the nature or cause, but it will not be expected to send wheels for the return of its stock, unless the damaged ones are sent back to it.

All repairs required to a foreign vehicle, which one or other of the contracting parties has to repair in order that it may continue its journey, are performed at the cost of this party, although it may ask the owning company to forward the parts necessary to carry out the repair.

When the damage to a vehicle is such that it cannot be returned on its own wheels it must be loaded up on another vehicle. This return journey as well as the forwarding of the repair parts asked for or the return of those parts which have been damaged or become useless, is always done by means of the ordinary train service without charge, but the administrations keep account of the value of the repair parts forwarded, according to the scheduled prices given in an appendix to the Regulations.

Scandinavian Conventions (International and Interior) and Regulations of the German Union.

A. — All losses or damages that have occurred to other companies' wagons or to their parts are, when they exceed 50 fr. charged to the administration using the wagon on the line of which they were first noticed, under the following chief conditions :

a) The axles and wheels must always be gratuitously replaced by the owning administration, in return for the old parts;

b) The costs are invoiced, even when they do not exceed 50 fr., if they are to be charged to individuals;

c) The loss of loose or detachable parts is carried to the accounts, whatever may be the cost of their replacement.

The prices for the more common repairs are given in an appendix of the Convention. As regards repairs, the cost for which is not included in this appendix, the material which has been used is invoiced at cost price and the workmen's wages at the current rate plus 100 % to cover workshop expenses and small details which cannot be invoiced.

B. — The cost of repairs and new parts must not exceed the sum obtained by deducting from the value of the wagon when new (excluding the axles and wheels) $1/6^{th}$ of the cost of fitting it out (value of the old material remaining) and assuming a life of 30 years deducting $1/30^{th}$ of the remaining $5/6^{ths}$ for every year of its life, the minimum to be $5/12^{ths}$ of the full value.

C. — This system involves the necessity of recording damage to vehicles in ordinary use at the time they occur, so as to be able to check later the charges made for the repairs. With this object it is stipulated that the damages — with the exception to those of parts specially listed — are reported by the station where they have occurred by means of labels fixed on the framing of the vehicle; other damages that may occur later on must not however be put on this label, but on fresh ones placed by the side of the first one.

D. — On the other hand, at all transit stations, the wagons must be checked over by the employees of the administrations who are working there jointly and who particularly notice whether the damaged wagons, although fit to proceed, have the proper labels on them.

E. — Damage which has occurred to wagons of another line and which may be easily and immediately repaired on the line of the administration using the wagon, must be repaired without delay at the station where it is noticed. If it is thought that the wagon cannot,

without injury or danger, continue its journey loaded, the administration of the line on which the damage was found must unload it at its cost and according to the nature of its damage send it back to the owning administration, or to its own nearest workshop to be repaired.

F. — The carriage of repair parts and the return of similar parts that are damaged, as well as the conveyance of wagons that are incapable of running, is to be carried out gratuitously.

Regulations dealing with damage to rolling stock arranged between the French administrations and extended to their relations with the Belgian State and Italian State Railways.

As a general rule repairs due to damage must only be taken in hand by the owning administrations, except such work as is necessary for the safety of general running. If such a repair cannot be carried out the vehicle is returned on a truck to the owning administration.

When the damage to a vehicle belonging to one line occurs on one of the other lines and is such that by means of a temporary repair this vehicle can be put into such a condition that it can safely run on an ordinary train, this temporary repair is effected at the cost of the company which does it (1), but the completion of the repair is at the cost of the owning railway.

If this cannot be done, the vehicle is dismounted and sent back on a truck to the owning railway, but in this case the charges for repairs are paid by the line responsible at cost price, exclusive of costs relating to the fitted axles.

No checking of damage is made either in the junction stations or in the workshops of the owning administration, by the other railway. When the damage is such that an invoice is necessary, this is accepted without discussion by the administration responsible for the damage.

(1) Repair parts supplied by the owning railway are not invoiced.

The points dealt with in paragraphs *A* (*a*) and *F* of the above summary of the Scandinavian and German Union « Conventions » bear a marked resemblance to French regulations. The subject treated in paragraph *B* (charges for replacements) is arranged in a similar way, but the annual depreciation is calculated at only 1 % per year of service of the damaged wagon, instead of 1/30, and no minimum is fixed.

On the other hand, when the vehicle is entirely destroyed or lost, and the administration responsible for the damage or loss does not return to the owning administration, either the remains of the vehicle or the fitted axles, it must pay to the latter the total first cost of the vehicle including axles and wheels less 0.75 % per year of service of the vehicle.

To sum up, the line responsible for the damage has nothing to pay to the owning railway for repairs effected by the latter, except in cases where the wagon has been totally destroyed or sent back loaded on another wagon.

R. I. V. « *Convention* ».

As in the preceding case, no checking is done by the two parties, and the repairs to damaged wagons must in principle only be taken in hand by the owning administration. Neither is there a minimum charge stipulated for repairs below which the latter are not invoiced to the line on which the damage occurred, and the invoice sent must be accepted without discussion by the administration which is responsible for the damage.

Finally, as in the case of the French Regulations, the sum to be paid for a wagon condemned to be broken up is calculated by deducting from its stock value that of the mounted axles then, from the difference 1/6, and from the remaining 5/6 1 % per year of service; this differs, however, from the French Regulations, inasmuch as the same yearly reduction (instead of reducing it to 0.75 %) is applied in the case of a vehicle that has been lost or has disappeared.

On the other hand, the « convention » contains the following original provisos :

In order to fix the sum to be paid for a wagon broken up or destroyed, the amount obtained as explained above, must be multiplied :

By 4 for wagons put into service before 1 January 1916;

By 3 for wagons put into service from the 1 January 1916, to the 31 December 1917.

For wagons put into service from 1 January 1918, no alteration will be made to the result obtained. On all other points the R. I. V. « Convention » closely resembles on the whole, the second type of « convention » summarised above.

Various « Conventions ».

The preceding regulations control the relations between the most important railway systems of Continental Europe; all other regulations in force resemble more or less one or the other of those which have just been summarised.

Examination by the companies at the junction stations in general (Spain, Great Britain (1), India and other British Colonies, Switzerland) and the conveyance of damaged rolling stock other than that of repair parts is free.

In Spain, wagons are repaired on the spot or in the nearest workshop; in case this is impossible, they are returned on a truck to the owning line. In Great Britain, light repairs are done on the line where the damage occurred; the wagons are only sent back to the owning line in case they require more repair than the former is able to deal with. In British India the receiving line does the repairs and replaces the missing parts, in order to keep the wagon in a running condition. In case of damage necessitating its conveyance on a wagon, the debris is forwarded to the owning line.

The cost of the repairs is generally dealt with by the administration on the line of which the damage occurred; exception is sometimes explicitly laid down in the case of an inherent defect (Algeria, Spain) (1). Also, no invoice is made out.

In Switzerland it is borne when the cost is below 50 fr.

In Great Britain, since the pooling of the stock, all renewals of parts are carried out by the owning railway and the costs of repairs done by another line are invoiced by the latter to the owning line.

In British India, the necessary parts supplied to the receiving line to do the repairs are invoiced to it, but it keeps all the broken parts, except the wheels and axles, which it returns to the owning railway.

On the other hand, if on the arrival of a wagon at a junction station, damaged or missing parts are noted, the receiving line invoices them to the delivering line on the following conditions :

1° In the case of a single vehicle when the cost exceeds 100 rupees;

2° When the cost of each missing detail or component part of the wagon is 10 rupees or above, with the exception of specially named parts which must be paid for in any case.

The line responsible is generally held to accept the invoice as made out by the parent railway. With the same idea in view, the Spanish « Conventions » stipulate that before damaged stock is returned, it must first be seen by inspectors for the two railways so that each side may report on it.

In conclusion, we will point out that the « Convention » of the Companies of British India stipulate that in order to avoid detention of wagons on another line owing to waiting for repair parts, the lines concerned shall supply sufficient quantities of special or non-standard fittings to each of the interchanging lines to be kept in a store at a central station.

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(1) It may be supposed that this has been done away with since the pooling of rolling stock.

(1) The exception, however, only includes the repair of the damage itself and does not include the consequences of the accidents, which may have resulted from the damaged vehicle, for which the line on which they occurred remains solely responsible.

Chapter III.

Loose fittings.

Interchange of rolling stock between neighbouring railways necessarily entails that of the loose fittings used to protect or fasten the goods conveyed. The interchange of these fittings, as far as international European relations are concerned, has already been subject in a large measure to regulations very similar to one another, and rules of a more uniform nature will be applied when the R. I. V. « Convention » comes into operation. These are a reproduction word for word, as far as this question is concerned of the regulations of the German-Italian Union and that of the International Scandinavian Conventions, which are themselves similar to the German Union Code. The clauses are as follows (1) :

All loose fittings used in loading and for which it is intended to make other companies responsible, should possess, wherever possible, the distinctive mark of the owning railway. These fittings should also be shown on a list attached to the way-bill.

In the case of returning an open wagon protected by sheeting belonging to the owning railway, the sheets used by the dispatching station may be left on the wagon. The original list is endorsed accordingly and continues to accompany the sheets until their return on the lines of the owning administration (2).

The same procedure is adopted in cases where the load is transhipped on the journey.

On the return journey, the loose fittings (sheets, chains, ropes, racks, packing) must not be used except for consignments destined for the owning administration. Those for which there is no use under these conditions must be sent back free of charge to their departure station, by the lines used on the outward journey, and with the original list, within ten days after the unloading of the wagon. The fittings used for loads sent to stations belonging to another company where the wagons (which the fittings accompanied) are to be used for consignments destined for stations on the line of the administration to which they belong are also carried free of charge.

Loose articles (which have accompanied loads) not in use should be returned to the owning station by the most expeditious means.

Administrations which are involved in the return of a sheet, are each allowed 5 days, starting from the day following the one on which it actually arrived at its destination, for returning this sheet either on to the next railway or to the owning railway. If the total of these time allowances exceeds this limit, the owning administration has the right to claim from the lines on which the 5 days have been exceeded demurrage of 1 fr. per day above the number allowed (except in cases where exemption for the wagon has been allowed). An administration responsible for wrongly sending the sheets on their return journey is charged from the expiration of the time allowed up to the time the sheets have reached the owning line or one of the lines used on the outward journey (1).

Claims for missing or wrongly sent fittings are not entertained unless they are made within 3 months after leaving the owning railway. The owning administration has the right to claim, for each lost fittings, half or the whole of the cost of replacing it according to the kind of fitting. In Great Britain an agreed scale of recompense is in operation.

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(1) According to the R. I. V. proposed « Convention » in project, when the arrangements are not identical.

(2) The R. I. V., L. W. R., V. W. U., and other « Conventions » of the latter type stipulate also when returning them, the new despatching station should at once advise, by writing, the original dispatching station that they are sending the sheets back.

(1) The I. W. R. and V. U. W. (and other « conventions » of the latter type) stipulate that the time allowed for the return shall not exceed that fixed for the wagons, beyond which the administration at fault is fined 0 mk. 50 per sheet and per day, except in cases where exemption is allowed for the wagons

If a sheet is so damaged as to be beyond repair, it is considered as lost; the remains are left with the administration at fault which is charged as above for its loss. Damage of less importance is not taken into account (1).

In Spain, the « conventions » stipulate that the loose ropes shall be returned through the same junction as they entered and immediately after the unloading of the goods. As regards the sheets, these are generally allowed (2) to pass through and must be returned after a maximum detention fixed according to mileage failing the return within the specified free time a charge of so much per sheet per day is made.

In France, the « Rules for guidance » stipulate that no checking is made or account kept of damages occuring to interchanged fittings. No memorandum is provided to accompany them; they are simply referred to by their marks or numbers on the waybills.

Immediately after unloading they should be returned to a junction with the owning company or with the company from which they were received.

As regards settling for missing parts, the following arrangements will come into operation after 1 January 1922 :

The interchange of loose fittings necessitates the transit stations keeping an interchange register containing particulars of loose sheets, ropes, chains, wedges and trestles, and also for reserves of missing sheets and ropes, which certain vehicles are supplied with.

By means of these interchange registers, the central offices can arrive each month at the ballance of the interchange account for each kind of fitting, and charges are made on fittings not returned.

For the present, a summary only will be given of the position as regards sheets.

In Great Britain, as in the case of wagons, sheets come within the scope of a « common user » arrangement as between the Railway Cos. and for the moment no payment for the use of the sheets exists, the balance being adjusted from time to time by mutual arrangement. Chains, ropes, packing material used in connection with consignments destined for a station on a foreign line have debits raised on the invoice according to an agreed scale. Such charges, however, may be re-entered to the owning company with full redebit when the articles are returned within a prescribed time, and if returned after the prescribed period the defaulting Company is required to bear a proportion of the full debit.

Sheets are generally replaced if no trace has been found of them during a period of four years. Each company is responsible for its own replacements.

In British India, no charge is made for the use of fittings, and they must be paid for if not returned within six months, unless their value is below 5 rupees.

In Switzerland, loose fittings let out on hire to private owners form part of the consignment which they accompany; demurrage is charged to the receiving line in case of delay. Lost fittings are charged to the administration responsible for their loss; if this responsibility is divided between several administrations, the sum is apportioned amongst them « prorata » to the mileage.

In Portugal, the sheets must be returned with

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(1) The particulars in this paragraph and the preceding one concern the R. I. V. « Convention » only.

(2) The three agreements : of the Northern of Spain with Medina del Campo-Zamora and Orense-Vigo and with Madrid-Cacérès-Portugal and of the Madrid, on the other hand Saragossa and Alicante with the Andalusian require, in principle, that fittings that do not form an integral part of the wagons shall not be admitted to interchange, except on the following conditions :

1° Sheets sealed by the customs;
2° Fittings contained in sealed wagons conveying wagons which require the use of the said fittings;
3° Fittings which the companies have decided to admit by mutual arrangement;
4° Ropes which, if removed, might endanger the security of the loading.

When the fittings have been interchanged under the above conditions, they must be returned from the same station to which they were sent in the time taken by an ordinary goods train, as soon as unloading has taken place.

the wagons on which they were used on the outward journey, failing which demurrage is charged for each day's delay. If the sheet covers a wagon belonging to another administration which is sent back loaded, it must be returned to the owning railway after a detention calculated according to the distance. To cover losses, sheets and ropes are paid for at an average price.

Between certain Italian lines an arrangement exists by which a charge per day is made for loose fittings when used on the line of a Company other than the Owning Company, and in case of late return to the owners a penalty charge is raised. Fittings not returned within six months are paid for.

To sum up, the forwarding line, with very rare exceptions, supplies these fittings in some cases free; they must be returned as quickly as possible, failing which demurrage is charged, either by the control or at the request of the owning administration.

Whether penalty charges are applied or not, fittings which are not returned within a certain time are considered as lost. Some administrations have not considered it necessary to fix a period of detention; those that have, vary it from fourteen days to six months.

On the whole, most of the railway administrations have made efforts to simplify as much as possible the conditions relating to the interchange of loose fittings, either by abstaining from putting in claims in case of delay, or charging for articles of small value if they have gone astray.

Chapter IV.

Interchange charges.

A. — Offices dealing with interchange accounts.

A certain number of administrations have instituted offices whose duties are to keep the accounts relating to the wagons they interchange. Such is the case with the central control office of the National Society of Belgian Railways, the central control office at Utrecht for interchange with the Netherland Administration, who have not pooled their stock; the « Milkontor » belonging to the Swedish State Railways which deals with the mileage of their own wagons on foreign lines; the « Milkontor » belonging to the privately owned railways in Sweden for dealing with the wagons owned by the latter (1); the « Trafikkontor » which is an office forming part of the general management of the Danish railways for the interchanges between all the Danish railways; the « Railway Clearing House » for the British railways and the central office at Berne for the Swiss railways. A similar organization was being put forward for the interchanges between the Indian railways when our list of questions was replied to.

Quite recently (1 April 1920) the French railway administrations commenced this way of working, when they put into operation « Rules to follow for the utilisation of goods rolling stock on the French railways ». As we have already seen, this « convention » has formed a general organization called « Central control for the running of wagons » ; it is authorised, in addition to other powers, to make out and settle interchange accounts and returns of goods rolling stock, both for the use of vehicles interchanged between French participating railways and for stock interchanged by the latter with the railway administrations of foreign countries.

Interchanges which are not settled

(1) This office is a private undertaking which has arranged to look after the mileage of wagons for an agreed sum.

through the intermediary of central control offices are managed directly by the administrations concerned. When amongst the interchanged wagons there are some which have been sent to the forwarding line by a third administration, these are thrown in with the wagons of the forwarding line, or else the matter is settled with the owning railway according to whether or not there exists a « convention » between the latter and the receiving line.

The preparation of accounts is generally undertaken by the Company due to be paid, and these are forwarded to the Company by whom payment is to be made. In the « conventions » between the Spanish Northern and Madrid-Saragossa-Alicante Companies, this business is placed alternately in the hands of one or other of the Companies in years with even numbers, and of the other in those with odd numbers.

B. — Method of making out interchange accounts.

In addition to the checking made on entering or leaving the receiving line (see chapter II, paragraph 2), most of the administrations take various steps with a view of facilitating the preparation of accounts, allocating the responsibility in cases of detention, wrong sending or the back use of foreign stock on its return journey.

The most important of these measures are :

Fixing on foreign wagons as soon as they are taken in hand (1), labels indicating the station by which they entered, the name of the forwarding line, the date of its receipt and when a time limit is assigned for the individual return of each wagon, the date of its expiration;

The filling in of a memorandum which accompanies the wagon and on which are given the dates and numbers of the trains departing and leaving for the different junction stations;

Keeping in each station, books which contain particulars of all wagons and loose fittings belonging to other lines that are at the station.

In the R. I. V. « Convention », which reproduces almost word for word the international agreements and « conventions » already in operation, it is stipulated that when on the outward journey, at the time of passing from the lines of one administration to those of another, the wagons must be supplied with a label (0 m. 13 × 0 m. 09 [5 1/8 × 3 1/2 inches]) by the forwarding line on which is written the name of the interchange station, the forwarding and receiving companies and the date when handed over. They must be stuck on the left end (as regards the reader) of each wagon frame and must be placed one beside the other from left to right and not cover other inscriptions which may be there. They must not be removed until the wagon has been returned to the lines of the owning administration.

When the central control for the circulation of wagons was first instituted, the French lines tried a new method of drawing up the interchange accounts, the essential clauses of which are as follows :

Each wagon on the register for interchange has at the Central Control a corresponding label on which is inscribed its registered number and other characteristics.

These labels are of various forms (top edge being convex, straight or concave) according to the type of wagon (covered, flat, open), and of different colours, according to the owning railway.

All the labels of the same railway are grouped together, but arranged in compartments ac-

(1) We have seen that in Spain the labelling done by the delivering line.

cording to a table, each compartment of which corresponds with one of the lines between which the wagons happen to be distributed.

By means of the interchange returns sent in by the transfer stations, the particulars of the interchanged wagons are written on their labels, the date of interchange, the name of sending and receiving stations, then the label having been filled in is put in its order in the compartment appropriated for the receiving line. These particulars are kept in order by means of the returns furnished by the sending or receiving stations. It is thus possible by counting the labels according to type and compartment to find out very rapidly the distribution of the stock of one line between all the other lines and consequently the total number of wagons occupying a given line at a given date.

Whatever measures may be taken to draw up interchange accounts, it is very difficult practically to obtain an entirely satisfactory result. When dealing with the methods adopted for the calculation of the dues, we pointed out how (chapter II, paragraph 4) complicated the getting out the individual account for a wagon was, as particulars must be kept of the route, the details of its journey, special days (Sundays, fête days, etc. which may occur during its journeys. Even in the much simpler case where the interchange accounts are based on the difference of balance, and it consequently suffices, in principle, to know the number of exchanged wagons ; possibilities of making mistakes are still numerous. In fact it cannot be confined to simple counting; it is necessary to keep trace of the identity of the interchanged wagons and consequently compile a return for each one of them at the time it is handed over or given back, with its characteristics. These returns are, moreover, made out under the worst conditions for correctness, the staff to which this duty is allotted, working on the line are nearly always hurried on account of the little time they have before the departure of the train, and often inconvenienced by the inclemency of the weather (rain, wind, cold, etc.), or else by darkness. The particulars they should register are sometimes hidden by load, sometimes they are difficult to read, and the mistakes made in consequence are all the more difficult to rectify, as the same number is frequently allotted to a series of vehicles which are only distinguished from one another by the letters of the series to which an index mark may or may not be added. This state of affairs necessitates inquiries which become increasingly laborious as the number of lines increase and transfer points become more numerous; when the inquiries are abortive after a reasonable time, it is necessary, in order to apply the « conventions » which contain the individual regulations relating to the wagons, to deal with the wagon as « an average », that is to say, apply the average charges calculated for wagons, the working of which has been noted regularly. This is, however, unfavourable to the owning railway, for the wagons of which trace has thus been lost have generally been detained for a considerable time.

The system now being tried in France appears to be one that will reduce these inconveniences, but it requires perfecting. This is now being done, and the results obtained from first experiences are still too recent for it to be possible to yet state the practical value of the system.

C. — Period for settling accounts.

Most of the administrations only make up their interchange accounts once a month at the most — some only quarterly — and it is some time after the end

of the period covered — generally more than a month — before they send them forward.

The R. I. V. « Convention » stipulates that the accounts shall be drawn up monthly and presented by the debiting administration to the department appointed for this purpose, before the end of the second month following that in which the wagons were sent.

Some of them do not settle the penalty charges under the same conditions as those arranged for the receipts.

D. — Filing accounts.

The time limit allowed for filing the accounts with a view to further research varies in general from two to seven years, except that it is as low as one year on certain British Colonial lines, and as high as ten years on the Italian State and Northern of Spain Railways.

These papers increase in quantity each year with the opening of new lines and the development of traffic on those already existing, and it is therefore desirable that they should not become too cumbersome and that the period they should be kept should be as short as possible. It is interesting to point out that with these ideas in view the regulations of the « Railway Clearing House » specify different time limits according to the nature of the documents, accounts properly so called being kept longer than the returns from which they were made out.

Experience fixes for each administration the time limit beyond which it has never had to refer to these records; it is easy therefore to decide whether or not the time for keeping them should be reduced. The wide divergence noted between the different administrations in this respect gives one an impression that the longest period might be shortened with advantage.

E. — Cost of drawing up the accounts.

Comparison of the figures furnished by the different administrations do not allow any precise conclusion to be arrived at, in fact certain replies include, in the costs given, those relating to the station staffs; others only deal with the staff of the central offices, some of them do not give particulars concerning office costs.

As regards the number of wagons dealt with, some replies give the total number of wagons interchanged, but in general each administration only deals with the wagons it takes over and only checks, chiefly from papers, the account for wagons it has forwarded, which has been got out by the receiving administration. Nevertheless, taking into account these various features, it may be said that :

1° The office costs vary in general from (1) 1.8 to 3.5 % of the cost of the personnel;

2° The overall net cost of operation compared with the Central Office expenses (excluding stations) varies as one to three.

This difference of one to three is a considerable one, it probably may be partly only apparent, because the figures which have served to get out the costs cannot be compared on every point, as has already been explained. The organization of the offices and the salary rate must also have an effect, as well as whether the particulars given relate to a more or less

(1) This proportion exceeds 7 % on the Italian State Railways, and 10 % on the Swedish State Railways.

recent date. It may be assumed, however, that the basis on which the accounts are made up has a very considerable influence on it ; thus, their preparation which is relatively simple when it is only necessary to verify the despatch of a wagon to the receiving line and its ultimate return to the sending line, becomes singularly complicated when it is necessary to calculate the mileage as well, to fix the number of days without penalty charges to which it is entitled, to take into account Sundays and fête days, detentions at the customs, conditions for unloading, etc.

Chapter V.

Rules dealing with disputes relating to reciprocal using of the stock.

Disputes of this nature are hardly ever brought before the ordinary courts of justice; differences are always settled by arbitration (1). The principal arbitration courts are constituted as follows.

International Union.

The Committee is composed of one delegate from the administration of the Belgian State Railways who is president, two delegates from the French administration, two delegates from the German administrations, one delegate from the Belgian Companies and one delegate from the Dutch administrations; its decisions are final.

I. W. R. « Convention ».

The Union of adherent railway companies forms a committee representing nine administrations. This committee has, in addition to other powers, that of being able to settle (1) disputes between members of the Union, without their going to law, although when the provisions of the Union have been interpreted with a view to settling a dispute of this kind, this interpretation need not be taken as final without going to law.

Members of the committee who represent the interested administrations must not take part in the discussions and decisions.

R. I. V. « Convention ».

The proposed rules provide for a committee to settle particularly, at the request of one of the adherent administrations and after hearing the interested parties, differences of opinion that may arise with regard to the application of the provisions of the « Convention ».

Railway Clearing House. (Great Britain).

A Claims Arbitration Committee, composed of Goods Managers is appointed to decide cases of disputed liability, but its powers only extend to the decision of claims not exceeding £200 arising from through goods traffic. Other disputes are submitted to an Arbitration Committee of Superintendents which is composed of twelve elected members.

Rules of Procedure (France).

Differences arising from the interchange of stock are submitted to a « routing » committee, composed of one delegate from each of the adhering administrations; its orders become absolute when, after a delay of one month after sending the official report to the heads of the operating departments of these administrations, no notice has been taken of it by the latter.

Indian Railway Conference Association (British India).

The Rules of the Association make provision for the construction of an Arbitration

(1) In South Africa and Australia, disputes are always settled by agreement between the heads of the two companies.

(1) Some companies reserve the right of appeal to the Law Courts when it is a question of legal disputes having a financial bearing.

Committee, the powers of which are limited to the questions within the scope of the said Rules, or those which the Association decides to submit to the Committee, with the exception of those questions which come within the province of the « Claims Arbitration Committee » (pecuniary claims from 50 to 5 000 rupees; the latter figure may, however, be exceeded if the parties agree). The Committee is made up of one or several arbitrators chosen by the President from the officials of the Association. The ruling of the arbitrators is final.

Spanish Conventions.

Disputes that are within the scope of these are dealt with officially and without appeal by friendly arbitrators chosen by the parties, according to the law relating to civil jurisdiction.

Belgian Light Railways.

Differences are arranged by means of arbitration, each company choosing its arbitrator. In case of disagreement, the difficulties are settled by the National Company of Light Railways, who gives a final decision to the companies at variance whose contentions they have investigated; its decisions are without appeal.

Holland.

Differences are settled by an arbitration tribunal, the rulings of which are without appeal.

Denmark.

The arbitrator is the Minister of Public Works, whose ruling is final.

Sweden.

Disputes are brought before a jury composed of five members; each party appoints one, the three others are nominated by the « Swedish Industrial Technical Institute appointed to settle disputes ». Its decisions are without appeal.

Italy.

Arbitrators are chosen by agreement between the two parties; in case of disagreement, they are nominated by judicial authority.

To sum up, the agreements that have been come to, make it possible for nearly all disputes to be settled finally without appeal to the Law Courts.

PART II.

RELATIONS BETWEEN RAILWAY ADMINISTRATIONS AND CONSIGNORS AND CONSIGNEES.

The nature of these relations varies according to whether the operations of loading or unloading take place in a station open to the public, by a railway administration, or on a privately owned line, generally called a « private siding », and also as to whether the rolling stock belongs to railway companies or private owners. We will rapidly review the various regulations adopted to meet these different cases.

Chapter VI.

Consignments despatched from or received at Stations.

a) **Conditions to be carried out by administrations and consignors concerning the supply of rolling stock.**

The methods followed in these cases vary considerably from one country to another, and also, to judge from certain replies to our list of questions, in parts of the same country. The most drastic

code of rules, as far as railway administrations are concerned, is that which is applied in France, Algeria, Belgium (State Railways), and in Switzerland; in these countries a request for stock according to the terms provided for in the regulations, places upon the administration who receives it an obligation which, if unfulfilled, renders it responsible; this obligation is defined as follows in the four countries mentionned above.

France.

The regulations in force are settled by an Edict of the Minister of Public Works. The day following the receipt of the request for wagons by the sending station, the administration is obliged to inform the consignor the day and time when they will be placed at his disposal. The time allowed for supplying is fixed, according to the case, from the day following the request or from the date given by the consignor for this supply. The severity of this provision is, however, lessened by the increase in the time allowed for the supply provided for in most of the special rates which allow the administrations an extra time, generally fixed at five days, which allows them to arrange for a supply of wagons, and also obtain a better use of their stock.

When a consignor has been advised that his request for stock will be complied with at a certain time and place, he may, if the engagement is not kept, require that the loss thereby incurred (shunting, etc.), shall be paid for.

Algeria.

The Administration of the State Railways and that of the Paris-Lyons-Mediterranean Algerian Railways must, within four days after the receipt of the usual request, inform the consignor the day and time when the wagons will be at his service; if it has not been able to give satisfaction within this time limit of four days, it must give a receipt for the goods, for the custody, preservation and loading of which it will be held responsible. The time for conveyance is calculated from that of delivery of this receipt.

Belgium.

On the State Railways except under circumstances outside their control, or for any other cause for which the administration cannot be held responsible, a request for ordinary wagons must be satisfied within the customary time allowed, in default of which the consignor has a claim against the administration.

Light railways need only supply stock as far as their means allow them to.

Switzerland.

The time allowed for the supply of wagons is 24 or 48 h., according to the size of the station, commencing from the receipt of the customary request. If this is not acceded to within the time specified, the consequences are the same as in Algeria, but it is also stipulated that if the stations request it, the consignor must deposit the amount due for one day's demurrage at the time he asks for the wagon.

Other countries.

In Great Britain, the « Railways and Canal Traffic Acts » oblige the companies to supply wagons for reasonable business requirements, with the exception of what is known as class A traffic and a few other descriptions of traffic.

The Australian, Danish, Spanish, Indian, Italian, Dutch, Portuguese, South African, and Swedish Railways have no formal obligations to fulfil when wagons are requested. Some are not held liable to supply wagons beyond the means at their disposal, others consider that these requests are simple indications of requirements which put them under no sort

of obligation (1). Nevertheless, in Spain, the consignors have the right to deposit their goods on the wharves, and for which the administrations must give them a receipt. This does away with any time limit, but the administration must carry out the loading, although under the conditions (under which the rate was made), this should have been carried out by the consignor.

The « Great Indian Peninsula Railway » also accepts goods in stations for which it cannot supply rolling stock, and loads it up according to priority.

The «New South Wales Government Railway » is only responsible as far as the conveyance of cattle is concerned. In case of nonsupply, the consignor has the right to claim the actual costs of feeding the cattle while waiting to be loaded up.

In Italy, the consignor must, at the time of making his request for the wagons, deposit 50 l.; in addition, if the request is made at a station which normally is not able, owing to its size and arrangement, to deal with such a request, he must make a further deposit of 16 l. 80 earnest money per wagon. These deposits are appropriated by the company if, the wagon being provided, the consignment is not delivered within the time allowed, which is fixed for each class of goods. The monies are returned if the wagons have been used as anticipated, or in the case of the earnest money, if they have not been delivered in the time mentioned in the request, which should be made at least thirty-six hours before the stock is actually required for use.

b) **Time allowed to consignors and consignees for loading and unloading.**

The time allowed is generally the same for loading and unloading, when in the latter case it does not exceed twenty-four hours. Only the Dutch railways allow longer time for loading (24 hours) than for unloading (8 hours); in other countries when the two periods do not agree, greater time is given for unloading.

The time allowed for loading varies from eight (1) to 24 hours, and for unloading from 8 to 48 hours — with three (2) days in exceptional cases. In some countries the time allowed is always the same; in others it varies with the number of wagons and the rate (3) or with the season, and the benefit of reduced rates is sometimes only given if the loading and unloading have been accomplished in a proportionately reduced length of time.

In Italy, railways may in case of congestion in the stations reduce the time allowed for removal to a third, and increase the charges for standing idle during the whole time the congestion lasts.

In Switzerland, the time allowed for unloading is reduced from 24 to 8 h. during the Autumn traffic.

c) **Hour from which the time allowed is calculated.**

This is fixed with more or less precision according to the countries. More

(1) On the Dutch railways, if a wagons has been promised and not sent in time for it to be of service, the consignor may claim compensation, but as they are not obliged to reply to a request for wagons, the employees have orders not to make such a promise, so that the situation is practically the same as if the company had no formal obligation to fulfil.

(1) The only ones that allow less time are the « South Australian Railways » (3 h.) and the Portuguese railways (7 h. from the 1 April to the 30 September).

(2) In England the time allowed is two days in stations and ports, and three days at private sidings. For sea-borne traffic at ports the Scottish railways allow two days.

(3) In Italy, the time allowed for loading is reduced for provisions to half an hour, for cattle to 3 h.; the time allowed for unloading is reduced for provisions; to 6 h. after sending the advice notice by express messenger; to 12 h. after sending it by post; for cattle to 4 h.

In Sweden the time is reduced from 12 to 6 h. for dead meat and to 2 h. for living animals.

often than not it depends, as regards arrivals, on an individual advice note sent to the consignee of the wagon, which may be forwarded to him either by post, express messenger, telegraph, or by telephone. The railway, however, only charges the consignee postal expenses, unless other and more costly methods for the advice have been asked for by the latter.

In some cases, the time allowed for unloading starts from the moment the advice note has been delivered to the consignee — a delivery which is usually determined by contract according to the time at the depot, when it concerns an advice sent by post or by wire; sometimes delivering the advice note is included in the time taken for sending it, in addition to that required for unloading, even if the advice is despatched by post or telegraph (1).

In Spain, a daily collective advice of all goods arrivals is posted up in the town offices or town halls. The time allowed for unloading begins from the mid-day after the posting up.

In Great Britain, Australia, and British India, an advice note is not in all cases obligatory, but it is usually sent; the free period begins when the wagon is placed or reputed to be placed at Consignee's disposal.

The system adopted is the same in France and Algeria both for dispatching and receiving. In Switzerland, the free period of 24 h. allowed for loading empty wagons placed at the disposal of the consignor starts, according to the nature of the case, from the day and hour indicated on the order note for the wagon, or from the time the wagon was put in position for loading.

Several Countries state that the free period commences as soon as the wagon is placed ready for use without precisely explaining how the consignor is informed.

d) **Demurrage.**

When the operations of loading or unloading wagons have not been accomplished in the time allowed, charges for delay are made, called demurrage charges. There appears to be little use in giving figures concerning these, which would only have a very relative value, as on ac-

(1) A few examples are given below :

In France and Algeria, the rule is as follows ;

The operations of loading or unloading must be accomplished during the day the vehicles were placed at the disposal of the interested parties, provided the advice note for the purpose has been sent so as to reach them the previous day, before 11.0 a. m. on Saturday or a fete day, and before 7.0 p. m. (6.0 p. m. in Algeria) on the other days, and that the wagons shall be placed at their disposal at the usual time of opening the station.

In Switzerland, the consignor is allowed 24 h. for loading the wagons, counting from the day and the hour specified in the order for the wagon. The regulations applying to a consignee receiving wagons fully loaded do not fix the starting time and length of time allowed for unloading, but the total length of time including the delivery of the advice note and the unloading. It stipulates in fact that the charge for demurrage shall begin as a rule 24 h. after the date and time of posting the advice note, as shown by the date stamp of the post office, or failing which, from the particulars given on the advice note. The free period allowed is, however, increased in cases where five or more loaded wagons arrive at the same time for the same consignee, and at the same station.

The free period of 24 h. starts, for consignments advised by wire, 24 h. after the despatch of the wire, and for those advised by telephone, 24 h. after the telephonic communication.

In Portugal, as in Switzerland, the total period of 24 hours allowed for the delivery of the advice and unloading starts from the time the advice note was posted.

In Italy, the total time allowed is also 24 h., if the advice note is sent by express messenger but 36 h. are alloewd if the advice is posted.

count of the fluctuations in the changes, no comparison can be drawn between the various countries, some of which, since 1914, have even suspended them, in some cases on several occasions. It is sufficient to say that demurrage is generally calculated per day, but in France near the Metropolis, on the Belgian Light Railways, and in Holland — if not in other countries — the rate per day increases the longer the wagon is detained, *e. g.*, in Great Britain on ordinary wagons 3 sh. each for first two days, after the usual free time, then 5 sh. per day for each subsequent day's demurrage.

e) **Remittance of demurrage charges and reimbursement of those collected.**

In principle, remittance of demurrage charges is never allowed, whatever may be the excuse offered. In practice, however, the French State Railways (France proper and Algeria) and certain Indian lines grant it in exceptional cases such as those of vis major. In England, rule 395 of the « Railway Clearing House », though not accepted by all the railways, stipulates that in the event of a consignee not being able to receive large consignments of determined traffic, notice specifying the description of the traffic and sending station must thereupon be sent by the receiving company to the original forwarding company to stop the traffic, and if this is not done the company so forwarding it is liable for all the demurrage charges that may accrue upon the wagons and sheets. In Italy, demurrage is not remitted, except in cases where large quantities of goods are unloaded without break, and under the best possible conditions.

As regards the reimbursement of demurrage charges after they have once been collected, many administrations admit it in principle, but only as an act of grace. In such cases they take into consideration the loss, more or less serious sustained and the nature and importance of their relations with the consignor or consignee, etc.

f) **Unloading by order.**

When the consignee does not proceed with the unloading of the wagons sent to his address within the time allowed, it may be in the interest of the railway administration itself to unload in order to liberate the stock more rapidly, either with a view to using it or to avoid congestion in the station. For this reason most of the administrations reserve the right to act under such circumstances at the consignee's costs, risks, and perils. The Belgian Light Railways have the power in such cases to send the goods on to the address of the consignee, the French railways have also similar rights.

The Italian railways, can, by virtue of their legal powers, order the wagons to be unloaded and charge the goods with storage rates.

Portugese railways can unload the wagons and place the goods on the warehouse platform at the cost of the consignees, if the latter do not take the necessary steps in the time allowed.

The Swiss railways have also the right to have the wagons unloaded at the cost of the consignor and to charge for storage from the moment the time allowed for unloading has been exceeded.

The French railways, moreover, have authority to order all goods that have not been removed within 24 h. after the time allowed for the purpose to be taken to a public warehouse.

The Swiss railways have this privilege also, but only after 25 days.

g) **Premium for unloading within the specified time.**

With a view to encouraging consignees to use their best endeavours to liberate loaded wagons sent to their address, certain French administrations have conceded to the latter, more particularly during periods of congestion in traffic when it was to their interest to have their stock liberated, a premium for any loading or unloading that was accomplished in less than the given time. Only the Orleans Company has not entirely discontinued the custom of allowing from the 1 September to the 31 December, generally the period of greatest traffic, a premium per day gained and per wagon of any capacity less than 20 t., this is increased 50 % for wagons of greater capacity.

The granting of a premium for quick unloading is evidently a means for increasing the efficiency of the rolling stock, but the fact cannot be hidden that while doing this it offers a means that is onerous — at least if applied to all wagons indiscriminately — for the premium has naturally to be paid to all consignees who fulfil the conditions imposed in order to enjoy the privilege, when many of them even without this stimulus would have taken their goods away before the expiration of the time allowed. It is most certainly with this idea that the benefit derived from premiums is limited to certain classes of goods, when time limits allowed are light and chiefly during the periods when traffic demands are greatest.

Chapter VII.

Consignments despatched from or received at private sidings.

a) **General particulars.**

The rules which regulate the supply of stock for this class of transport vary, not only from one country to another, but also from one administration to another in the same country. In Belgium Denmark, Italy [1], Sweden, Switzerland, South Africa, Australia, and on certain Indian Railways, the regulations are the same as those which apply to the stations.

In Spain, the companies sometimes stipulate in their contracts dealing with private sidings that the owners of the sidings shall take no proceedings against them in case of delay in supplying rolling stock, sometimes the supply is dependent on the limits fixed by the capacity of the lines, the nature of the traffic, etc.

The question is settled in France by special rates, certain clauses of which vary with the railways, the principal ones being the following :

The administration is only liable to supply wagons requested by the owners of private sidings, as far as the requirements of its own service permits [2], provided that goods arriving from the sidings reach their destination in the time limits fixed by the rates that may be applied.

The administration makes a charge to cover itself for the supply and cost of sending stock, by a rate per ton (of effective loading, or the maximum tonnage the wagon may carry, according to the railways) increased by a surtax per ton per kilometre above the first kilometre. On one of the railways the rate is charged per wagon, whatever its tonnage, when the siding is longer than 3 km. (1.8 miles).

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(1) Private sidings, however, have not to furnish the guarantee deposit of 50 l. nor the earnest money, the administration being guaranteed by their agreement.

(2) Certain lines stipulate that the wagons must be supplied in rotation as they are ordered, with a time limit of either 2 or 3 days, excluding that on which the request was made, and that of delivery. To this time limit may be added, if it be necessary, the supplementary time allowed by the special rates applied in these cases.

Each wagon used on a private siding is charged as a fully loaded wagon (generally 4 or 5 t.) even when it is not completely loaded.

The rate for hire is charged for wagons that have been requested by owners of sidings, even when they have not been used by them.

The owners of the sidings are responsible for damage that may occur to the stock during their stay in these sidings.

In England, companies are expected to supply wagons for any « reasonable » commercial requirements, the same to private sidings as to the stations.

On certain Indian railways, the supply of stock to private sidings is, as in Spain, made the subject of special agreements with the owners of the latter.

b) **Determination of the commencement of the time allowed for the carriage of goods leaving private sidings.**

In Belgium, the time allowed for detention of consignments starts, as for other consignments for goods trains, from the first hour of the day following the receipt of them, which takes place at the station and not on the siding.

In Spain and Italy, the time allowed for carriage begins also from the time when accepted by the station.

In Switzerland, the period allowed is calculated in the same way as for ordinary consignments.

In France and on the Paris-Lyons-Mediterranean Algerian Railways, it starts on the next day after the stock has been requested.

In Great Britain and its Colonies there are now no regulations relating to detention.

c) **Time allowed to private sidings for loading and unloading operations.**

In most countries it is considered that the existence of privately owned sidings, the lines of which directly serve the sheds and yards where goods are loaded or unloaded, allows the wagons to be dealt with in a much shorter period than when they are placed for this purpose in a station, and the carriage between this and the consignee's premises has to be carted. Thus, the time allowed for the operation (loading or unloading) is reduced by some hours, starting from the time the wagon is put on to the private siding. The Dutch Railways, those of the Danish and Swedish States as well as certain lines in Great Britain and India allow, however, the same time as that accorded to wagons delivered in the stations. The « South African Railways and Harbours » allow 12 h.; one Australian railway allows one uniform time of 10 h., and the other 3 h. for loading and 8 h. for unloading. Switzerland allows 10 h.; certain lines of India 9 h.; France and Algeria 6 h. for the first km. length of siding and half an hour more for each succeeding one; the times allowed separately for loading and unloading are added together, when a wagon that has been delivered loaded is also sent back loaded. It is the same in Belgium where the time allowed for the operations of loading or unloading is 6 h. for the State Railways and five for the Light Railways. In Spain the time allowed varies from 6 to 24 h. and is fixed either by agreements with the owners of the sidings or by the rates in use; it is sometimes increased when the wagon is returned loaded. In Italy the time allowed varies from 6 to 9 h., according to the distance and importance of the traffic on the siding, and this may at request of the owners, be increased to 12 h. subject to

a proportional increase in the charges for supplying the wagons. The time allowed in Portugal is 6 h. up to six wagons, and increased by one hour per wagon above six; when the wagons are returned loaded a further addition from 6 to 9 h. is allowed, and still further increased by one and a half h. per wagon above 6.

d) **Demurrage charges at private sidings.**

On the Railways in Great Britain more free time is allowed to deal with wagons at Private Sidings than is the case at stations. From time to time this is varied at private sidings in accordance with the exchanges and the wagons supply. At present for ordinary wagons the following free time allowance exists :

At stations before conveyance :
1 day exclusive of day on which wagon is placed at traders' disposal.

At stations after conveyance :
2 days exclusive of day of receipt by trader of notice of arrival.

At private sidings before conveyance :
2 days exclusive of day on which wagon is placed at traders' disposal.

At private sidings after conveyance :
3 days exclusive of day on which wagon is placed at traders' disposal.

With an understanding that time to the sixth day inclusive is allowed on wagons received loaded and returned at private sidings.

In France, the companies make a charge equal to the rate imposed for the detention of the wagons for each six or portion of six hours they have been detained (1). This demurrage charge may, however, on request from the owner of the siding, be calculated at the rate of 0 fr. 25 per wagon per hour they exceed the time allowed, night included (2).

In other countries the basis and rates for demurrage vary considerably; sometimes the charge is calculated at the same rate as ordinary consignments (Belgian Light Railways, certain Indian, Danish and Dutch railways), sometimes, according to the maximum capacity of the wagon (on some of the Indian railways) and finally, sometimes no charges whatever is made (Sweden with the interior traffic). As regards the time unit, this is arranged either per hour or for a period of 6, 12, or 18 h. or per day of 24 h. The Swiss railways moreover claim the demurrage charges that have been paid for foreign stock. The rate applied on a time limit is sometimes increased according to the seriousness of the delay (Belgian State, Great Britain, Italy and Portugal).

e) **Premiums in case of finishing the operations before the time allowed.**

The French Etat, Est and Nord Railways allow premiums, particularly with the object of encouraging the owners of the sidings to deal with the wagons during the hours when the stations are closed.

Chapter VIII.

Traders' wagons.

a) **Conditions of admission.**

These are nearly always the same (1) as for wagons belonging to the railway companies.

(1) On one line, the time allowed is 12 h. instead of 6, and it is specified that Sunday and fete days shall not be included in these charges.

(2) One company stipulates that at the request of the Owners the time allowed for the stay of the wagon in the sidings may be increased to 24 h., and that the demurrage charged in case of delay shall then be 2 fr. 40 per wagon per 24 h.

(1) In certain countries, British India especially, there are no privately owned wagons.

The latter generally stipulate that the plans of the wagons should be passed by them before they are constructed. In Spain and in France the conditions for admission are fixed according to the rates applied to wagons belonging to private owners (tariffs X No. 7 in Spain and G. V. 21 and 121, P. V. 29 and 129 in France). In Belgium, Denmark, Italy, Portugal, Sweden and Switzerland, they form the subject of special regulations. The French rates and the regulations of the Dutch railways conform with the Berne Convention for the technical standardisation of rolling stock.

In Great Britain, the conditions are fixed by the regulations of the « Railway Clearing House ».

In addition to the technical conditions properly so called nearly all the administrations insist on a minimum proportion of screw hand brakes.

Finally, some administrations (« South African Railways and Harbours » for instance) do not allow the wagons in question to run on their lines or only allow wagons of special types for freight that the railway companies could not carry in their own stock.

b) **Rebates allowed to owners of wagons.**

Belgium, Holland, Alsace-Lorraine, Switzerland (1) and the South African Railways and Harbours allow no rebates whatever. Spanish railways allow a rebate on mileage which varies according to the net weight of the freight carried. The French railways, exclusive of those of Alsace-Lorraine (but including Algeria) and Portugal, allow per loaded wagon, on the rated mileage, a rebate according to the rating which in France and Algeria varies with the normal loading of the wagons, or for tank wagons with their contents. The Italian State Railways allow to owners of wagons a mileage premium, reserving the right to fix the basis in each case by taking into account the type of vehicle, its value, special use, and freight it is designed to carry, of the costs of handling, traffic which the use of it allows them to obtain. In Great Britain and in the Indian and Australian Colonies, a rebate is given in the form of a lower rate when private owners' wagons are used than when the wagons are supplied by the railway companies.

c) **Time allowed for loading and unloading.**

This varies a great deal, sometimes no scale is fixed (Belgian Light Railways) sometimes it is the same as for ordinary wagons (Algerian, Australian, French, Italian, Portuguese, Dutch and Swedish railways (2), and finally, sometimes it is longer as on the Spanish Railways. Siding rent not demurrage is charged on Brittish railways. When a time allowance has once been fixed, demurrage is nearly always charged if this time is exceeded, in order to recoup the railway company for the costs of the lay out, sometimes considerable, it has incurred in providing siding accommodation for the wagons.

d) **Standing idle**

In order to reduce storing expenses, it is to the interest of railway companies to send certain classes of wagons that are idle for the time being to points on their

(1) The railways of this country undertake at their own cost various small repairs such as the renewal of brake shoes, etc., which indirectly constitutes a kind of rebate.

(2) With the exception of tank wagons.

line where they have suitable siding accommodation, either because the latter was arranged for this purpose, or for other reasons. In order to encourage the owner of the wagons to make use of these siding facilities, administrations in some countries allow him in this case to benefit by the accommodation offered at low rates.

In France a wagon may be ordered, to stand idle in the sidings, if after its arrival empty in a station it has not been loaded within a certain fixed time.

In Spain a rate is charged for the carriage of the wagon having to stand idle up to the station where it will be stored.

In Alsace-Lorraine, the station where a wagon is given special privileges when idle, is that to which it belongs, where it remains free of charges.

In Italy, the charge made is half in the station it belongs to to that at any other station; the same charge is, however, made in the latter case if the company has made use of the right it possesses to remove a wagon from its home station on account of traffic considerations.

In Switzerland, free accomodation is allowed at the station to which it is attached, but for fourteen days only, beyond this time the company reserves the right to transfer it to another station at the owner's cost. The charges made per day for storing under these conditions are light.

It should be pointed out that when the daily rate charges for storing an idle wagon have exceeded a certain limit, the consignee may find it economical to send the empty wagon to a neighbouring station, the costs of carriage being less than the charges due on the days included between the time when he sends in his application note for a journey, and that when he is expected to take charge of the wagon. The Danish regulations concerning the use of private wagons include an interesting clause, on this point; it in fact stipulates that as a general rule the mileage a wagon has run empty during a year must be at least equal to the loaded mileage, and if this is not done the owner must pay to the railway company a sum which in 1910 amounted to 7 c. 5 per axle per km. in excess of the mileage that had been accomplished loaded. This arrangement is evidently of a kind tending to prevent the running of the stock at a pure loss.

e) **Time allowed for the carriage of empty wagons.**

This is generally the same as for the freight. In Spain it is increased by three days : moreover — as is also the case in Alsace-Lorraine — a maximum per day per wagon is fixed for the rebate the consignor may claim in case the customary time allowed has been exceeded, as compensation for any loss he may have incurred.

f) **Upkeep.**

Upkeep and repairs are in general at the cost of the private owners to whom the wagons belong, however, during the journeys the wagons are examined and greased under the supervision and at the cost of the railway company, and the latter is responsible (with certain reservations) for accidents and damages happening on its lines. Some administrations undertake, by arrangement, the upkeep of the wagons registered on their line, on condition that the spare parts necessary are provided by the owner; the French administrations [1] even insist that they shall be examined by themselves at the yearly inspection which their

(1) With the exception of the Alsace-Lorraine Railways.

own wagons must undergo for the upkeep necessary to maintain them in a safe running condition, these repairs are invoiced at cost price (factory charges included) to the owning company in addition to the charges due for carriage.

g) Accounts between administrations and private owners of wagons.

There is no necessity for these accounts to be made out when the railway does not make a charge or when the terms for working a privately owned wagon make it necessary to apply a rate which includes this charge. In France (1) the charge for mileage is deducted from the charge for conveyance, if the latter is carried out exclusively on the French lines. When the wagon crosses to a foreign line, the charges allowed by the receiving line are subject to regulations which apply to the interchange accounts between the administrations concerned and are finally allotted to the owners of the vehicles through the intermediary of the railways on which they were registered. The owners of wagons registered by the Italian State Railways send in the account every six months for the journeys made by their wagons on other Italian lines and on lines of foreign nationality; the administrations of these railways collect the corresponding amounts and credit the owners of the wagons with them.

Chapter IX.

Supply of loose fittings to consignors.

The obligations of administrations to consignors as regards the supply of loose fittings varies considerably from one country to another. Chains and ropes are supplied free, or charged for according to circumstances, and in the latter case may be subject to demurrage charges in addition if kept beyond a certain time (1). As regards sheets, the supply is obligatory for certain lines, either on account of the nature of the goods or according to the rate in operation, in the latter case sometimes the rate stipulates that the railway company supplies the sheet free, sometimes that a charge is made for its use. Some rates stipulate in addition that the sheets shall be put on by the consignor and removed by the consignee at their own risks and costs.

The charges made are calculated in many different ways : per sheet per wagon; per sheet per day, per sheet per mile (with generally a minimum charge per sheet).

Sometimes (1) when several sheets are required for a load the charge is reduced by one half, except for the first one.

To these charges may be added demurrage charges, according to whether the time allowed for the use of the sheets has been exceeded or not.

The rates are also very variable, running from 1 to 5 for daily rating and from 1 to 2 when the rate is fixed according to mileage.

The system dealing with the supply of sheets, to private firms in France has recently been entirely reconsidered and standardised for all railways of general importance, and will be made part of the general code of rules which apply to special rates for goods traffic. The essential clauses are the following :

Goods which necessitate the use of sheets are classed in a list as follows;

(1) In Portugal, the charge is also deducted from the cost of conveyance at the time this is paid for.

(1) Swiss transport companies. Regulations and rates for collecting charges for accessories in operation since the 1 July 1917.

Goods, the conveyance of which may be carried out in open trucks, the sheeting of which is optional, these are sub-divided according as the sheets are supplied by the consignor or requested by him to be supplied, or in the case when the sheets are only provided by the consignor;

Goods which must be carried under cover, but for which the supply of an open wagon with sheets, does not entail a payment for each of the operations necessary for sheeting or unsheeting undertaken by the consignor or the consignee unless the former has made a written request for a covered wagon;

Goods for which, in exceptional cases, the supply of sheeting, if asked for by the consignor, and its supply is agreed to by the company without extra charge.

With the exception of the latter, these clauses only apply to consignments rated at prices which depend on one of the following conditions :

a) Wagon fully loaded, or wagon loaded to the limit of its load or capacity;

b) Minimum tonnage per wagon (whatever this minimum may be);

c) Minimum tonnage of 4 t. per journey.

The railway company need only supply open wagons for goods included in the list that may be carried without being covered, except in the following cases :

1° When the railway company undertakes the handling, the sender may request that the consignment be covered at the cost and under the conditions fixed by the rates for hiring sheets which apply to this case;

2° When the handling falls on the sender, the latter, unless the rules of the rating stipulate otherwise, has power to cover the goods either with his own sheets or with sheets hired from the railway company at the price and under the conditions fixed for this case in the above mentioned tariff. In either case the operation of sheeting the wagons and cost of it falls on the sender. In the same way if the consignee is responsible for the handling, the operation of removing the sheets and cost thereof falls on him. The return of the sheets supplied by the sender to the starting point is done gratuitously by slow goods on application being made.

For goods that must be conveyed under cover, the railway is at liberty to supply on their own responsibility either covered wagons or open wagons with sheets without making any extra charge. When the handling is at the sender's or receiver's risks and the railway has supplied an open wagon with sheets, the operations of sheeting or unsheeting are done by the sender or receiver, the railway company has to deduct (except in particular cases specially listed) from the cost of carriage 1 fr. per wagon for each of these operations.

The rates for hire are made up of two sums; one is a fixed charge and the other proportional to the mileage with a minimum charge.

Such is the new code of rules which is on the point of being put into operation in France, and which appears to fully comply with all the necessary commercial requirements.

We may add in conclusion, that certain administrations let out their sheets on hire to consignors and consignees to protect the goods placed in the stations before loading or unloading. The charges made for hire in these circumstances are generally much greater than those fixed for the use of sheets for ordinary transport.

SUMMARY AND CONCLUSIONS.

A. — Relations of Railway Administrations between themselves.

Since the time the question of interchange of stock was brought before the Congress in 1892, no change of any importance has been introduced into International Conventions. The regulations of the German-Italian Union have been revised twice, these revisions having been put into operation 1 January 1894 and 1 April 1914, but their fundamental bases have not been interfered with. The revision of 1882 of the International Union Regulations is still in force and the conventions of the French companies with foreign administrations with which they are in contact have only been subjected to touchings up of no importance, which were decided on by a simple exchange of correspondence.

We can hardly consider as a change the extension of the German Union Regulations to the Swiss Railways and the State Railways of the three Scandinavian countries; they only applied previously to Germany, Austria Hungary, Holland and Roumania. As regards the conventions in operation since 1913 between Scandinavian countries, these are a very close reproduction of the arrangements of the German Union, and consequently cannot be said to be an innovation properly so called.

The regulations of the technical standardisation of railways has been the subject of a simple revision, the last being that which was put into force 1 May 1914; it was incorporated in 1914 with a few additional clauses in the last edition of the regulations of the German-Italian Union; this is also in force between all the countries bound by the Regulations of the German Union or the Scandinavian Conventions which are similar.

Finally, the French administrations put into operation the 13 August 1899 regulations relating to damage to rolling stock which have taken the place of those of February 1887; it is a reproduction, except in a few details of the convention of the 29 June 1889 between the French Paris-Lyons-Mediterranean Company and the Italian State Railways, to which in 1901 the Belgian State Railways were added.

If however during these last thirty years we can only notice a tendency as regards international relations towards standardisation which is shown in the adhesion to the existing conventions, a change will take place shortly, when the final agreement will be reached as regards R. I. V. Convention which is now being drafted. This agreement offers two essential characteristics : in the first place it will interpret the new tendency — very much in evidence — in the direction of standardisation of the rules relating to the interchange of international rolling stock, since it is destined to take the place of the international Union, of the German Union (V. W. U.) for some relations, that of the German Italian Union (I. W. R.) and all the conventions of the French companies with the railway administrations of frontier countries.

Secondly, it will bring about the abolition of charging on mileage for numerous

interchanges, and by the substitution of charging for time will effect considerable simplification.

The changes in the conventions connecting administrations of the same country have been considerably more extensive. The code of rules regulating each individual wagon has been abandoned by degrees (1) and is practically only in use in the Scandinavian countries and in other countries between local lines with the big railway companies (2). The new systems which were put into operation in France and British India during the first years of this century have been themselves recently replaced — wholely in France and experimentally in British India — by systems based on pooling of rolling stock. In France this alteration has at the same time brought about the substitution of conventions passed between companies in pairs for one convention common to all (3).

In the presence of changes so recently instituted and of so wide sweeping a nature, it is only possible to wait the result of their working before advancing any conclusion. The practical value of the new formula can only in fact be estimated from experience, and for the present we must confine ourselves to asking the administrations who have taken the initiative to collect all the particulars of the results obtained and arrange them together in such a way as to facilitate comparisons later on.

The preceding considerations refer more particularly to that part of the conventions which relate to the basis on which the interchange wagon accounts are settled. As regards the other questions dealt with in the conventions, such as the conditions for admission to interchange, the settling of the costs incurred for repairing damages, interchange of loose fittings, the reduction of the number of conventions has brought about — and will continue to bring about — a marked progress towards standardisation.

It is only to be hoped that as regards continental Europe (1) continual progress will be made in this direction; it will simplify the work of the railway employees in saving them the trouble of having to consider the many regulations which are extremely difficult to keep in mind, as they differ often in details which are of no apparent importance. They will also reduce the troubles which these differences cause to transport without transhipping of freight which has to pass through zones where different conventions are in operation. It does not seem impossible *a priori* to thus arrive at results which may be compared to those obtained by the regulations of the technical standardisation of railways concerning the technical conditions for admission to interchange.

Finally, there is the question of undeniable practical interest, namely, that of drawing up the interchange accounts. These become more complicated each day with the increase in the number of in-

(1) It is interesting to point out that the reverse case has never occurred and that the method of settling individualy for each wagon has never been substituted.

(2) The French Midi Railway has, however, adoped the system of pooling with certain local lines.

(3) It should be pointed out that in Spain the adoption of one convention only would be rendered much easier, when they care to bring it about, on account of the almost complete similarity which conventions in pairs now in force have to one another.

(1) The eventuality of the construction of tunnels under the English Channel and the Bosphorus raises the hope that standardisation will extend to Great Britain and Asia Minor.

terchanged wagons, the building of new junction stations and new lines, and the continual increase in the different types of wagons. In the drafting of conventions this should never be lost sight of, and the thought of it should weigh the balance in favour of the arrangement which contains the simplest rules for drawing up the accounts, when another arrangement does not show an incontestable advantage to justify a greater complication in the accounts that would arise from it.

B. — **Relations between the Railway Administrations and the consignors or consignees.**

These relations are arranged on bases which differ greatly from one country to another. Sometimes the administrations are under very strict obligations to supply the required stock and they are held responsible in case of failure to do so; sometimes these obligations are vague and not binding, whilst in other cases the administrations are in no way obliged to accede to the requests of the consignors.

As regards the time allowed for loading and unloading, this varies considerably from one country to another, and occasionally in the same country, according to the rate, the time of the year, and even on account of congestion at stations. This applies also to demurrage charges when the free period has been exceeded.

One can see what an effect these different systems have on the use the various companies can make of their rolling stock, according as they are obliged or not to supply it and according to the longer or shorter time in which the consignors have the right to make use of it.

As regards private owned wagons, detailed rules generally fix the conditions for interchange and the advantages allowed either to the owners or to the users of these wagons. Some administrations only allow them to be used for certain classes of traffic; others have a different system for special wagons designed for freight not suitable for transport in their ordinary rolling stock, and for similar wagons to those which the railway companies have at their disposal.

The obligations under which the companies are to supply loose fittings and more particularly sheets are not less varied than those applying to the supply of wagons. In some cases the supply is obligatory and free, in others it is optional or granted as a favour; in the latter case the charge for hiring may depend on the number of sheets supplied; it is also fixed according to the journey, the time in which it is in use or the mileage. The French administrations are the only ones to our knowledge who have standardised the regulations dealing with this subject regulation which will shortly be put into operation and in which are defined the respective privileges and obligations which appertain to the companies and consignors in the various cases which may occur.

CONCLUSIONS.

With reference to the preceding remarks we advance the following conclusions :

A. — As regards the relations of the administrations between themselves :

a) Since the last discussion of the question at the Congress of 1892, new agreements have been reached with the object of realising a better utilisation of interchanged stock and to simplify the drawing up of the interchange accounts; for this purpose the contracting parties have abandoned the system of charging for mileage and generally the application of an individual penalty charge for each wagon. Some of them have adopted the principle of penalty charges which are applied only at the request of the forwarding line. Many have more or less joined together in the system of pooling.

The principles on which these innovations are based are reasonable, but some of those which are amongst the most important, and still on trial, are too recent to enable us to state definitely their real value, which can only be arrived at after some years of practical experience. It is therefore desirable that the question of interchange rolling stock should again be placed on the programme of the International Congress at its next session as regards the rules that should be adopted in the relations of railway administrations between themselves.

b) Interchange conventions between countries forming part of the same continent and having the same width of gauge, show that differences exist which are foreign to the very principle of conventions. These differences form an obstacle to interchange, and it is very desirable in consequence that they should as far as possible be abolished by means of an international agreement such as the one that ended in that concerning the regulations for technical standardisation.

B. — As regards the relations between the administrations and the consignors or consignees :

a) The considerable differences which have been found to exist between different countries as regards the time allowed for the loading and unloading of wagons seem to indicate that the methods adopted in some countries are capable of alteration tending to a better use of the rolling stock and to reducing congestion in the stations;

b) The system of daily demurrage charges at an increasing rate in case of the time allowed for loading or unloading being exceeded has been sufficiently proved to warrant its general adoption;

c) It is desirable that when dealing with privately owned wagons, the regulations should be made as uniform as possible. (This conclusion has the same object in view as that put forward in *A. b.*)

[656 .253 & 656 .259]

REPORT No. 2

(France)

ON THE QUESTION OF LOCOMOTIVE CAB SIGNALS (SUBJECT XII FOR DISCUSSION AT THE NINTH CONGRESS OF THE INTERNATIONAL RAILWAY ASSOCIATION), (1)

By Mr. JULES VERDEYEN,
ENGINEER IN CHIEF,
INSPECTOR OF MANAGEMENT OF THE BELGIAN STATE RAILWAYS.

Figs. 1 to 8, pp. 539 to 552.

The very interesting report of Mr. Maison, published in the *Bulletin of the International Railway Association* for November 1921, had been prepared for the Session which should have been held in Berlin in 1915. We have been entrusted by the Managing Committee of the Permanent Commission of the Association with the task of completing this report, so that it may be possible to inform the Rome Congress in 1922 of the actual position in France regarding the repeating of signals on locomotives and the recording of the setting of the signals.

In this supplementary report we shall follow the same order of headings as in the report of Mr. Maison.

SECTION I.

The repeating of signals on locomotives.

CHAPTER II.

Evolution of ideas.

§ III. — *Period subsequent to 1914.*

It is evident that the great world-war interrupted the work of the general fitting of repeating (cab-) signals on locomotives, the trial of which on a fairly large scale had been recommended by the Ministerial circular of 1911.

Further accidents that occurred in France in 1919 resulted in fresh Ministerial action; a circular dated 19 November 1919 insists strongly on the necessity « of devising means of repeating in the cabs of locomotives, the setting of home and distant signals, and of making without delay a definite selection from the vari-

(1) This question runs as follows : « Repeating and recording the track signals on the locomotive. Different systems already used or tried. Results obtained. — Recording the running speed of locomotives. »

ous appliances that have been subjected to trial on the various Railway Systems ».

This circular letter moreover requires, as an immediate step, while waiting for the cab repeating signals to be adopted, that fog signals (detonators) should be used to supplement the visual signals, and with this object the French Railway Companies are required :

1° To supplement by detonators all absolute stop signals, semaphores, and also the distant signals (discs) as well as the signals at junctions and other points of danger, except when these signals are fitted with electric or mechanical repeating appliances;

2° To ensure, on lines worked on the block-system, that trains stopped less than 1 000 m. (0.62 mile) from the semaphore that protects them, should be protected by means of detonators placed on the rail 1 000 m. (0.62 mile) to the rear of the train.

These temporary arrangements were to be carried out and put into force within a period not exceeding two months.

These requirements were obviously framed with the sole object of obtaining a temporary solution of the problem of repeating the signals in the cab of the locomotive and of forcing the Railway Companies to make general use of the repeating signals which they had already been asked to adopt in 1913.

Furthermore, since 1920, the great French Railway Systems had definitely made their selections. The French Northern retained its crocodile arrangement; the French Eastern, The Paris-Lyons-Mediterranean, the Orleans and the State Railway agreed to this apparatus subject to minor modifications, the French Midi Railway alone confined itself for the time to repeating the distant signals by means of detonators.

CHAPTER III.

Present state of modifications of appliances already tried.

§ I. — *French Northern Railway System.*

The appliances in use are the same in principle as those that were in use in 1913.

An improvement has been made in the fixed contact on the track (the crocodile) with a view to ensuring good electric contact in frost and snow. This contact has been made proof against hoar-frost by coating with paraffin which prevents hoar-frost or snow adhering to the surface on which the brush carried by the locomotive rubs. The brush, which has hitherto consisted of silicon bronze wires, has been replaced by another in which the wires are of special steel. These two appliances of Mr. J. Colas' system were described in the *Bulletin of the International Railway Association* for November 1921.

Other improvements on the arrangements described in 1913 are still being considered. They are intended to render the work of the apparatus complete by repeating the line clear signals, by marking on the strip of the Flaman recorder the indications given to drivers by the repeating appliance and how soon the driver took action when he found the signals were against him.

On single tracks, it is essential that the repeating of the signals on the locomotive should only relate to the direction in which the train is running. This condition is met by the addition of a « tumbler » in front of the crocodile which only allows the circuit to be closed for one direction of running.

The tumbler consists essentially of a

stirrup fixed to a shaft carrying a counterweight and a cam which acts on the contact springs. The contacts and the counterweight are enclosed in a watertight box which acts as the framing and is carried under the protecting shield of the fixed contact.

Figure 1 shows the general arrangement and figure 2 gives a drawing of the construction of the apparatus.

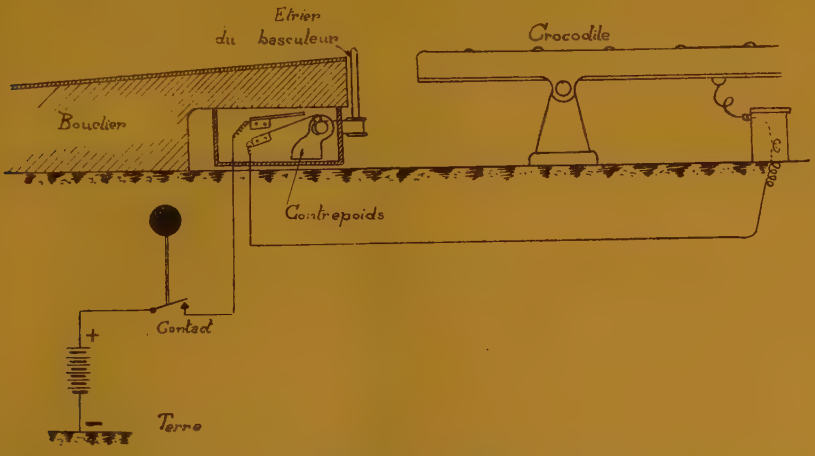


Fig. 1. — Arrangement of tumbler for single line.

Explanation of French terms: Bouclier = Protecting shield. — Etrier du basculeur = Stirrup. Crocodile = Crocodile. — Contrepoids = Counterweight. — Contact = Contact. — Terre = Earth.

When a train, running in the direction for which the tumbler is set, passes over this tumbler, the brush, in passing rubs lightly on the stem of the tumbler and throws it over; before it has had time to return to its normal position the brush has passed over the crocodile and taken the current, which has been switched on by the fall of the tumbler, and thus effects the necessary repeating and recording.

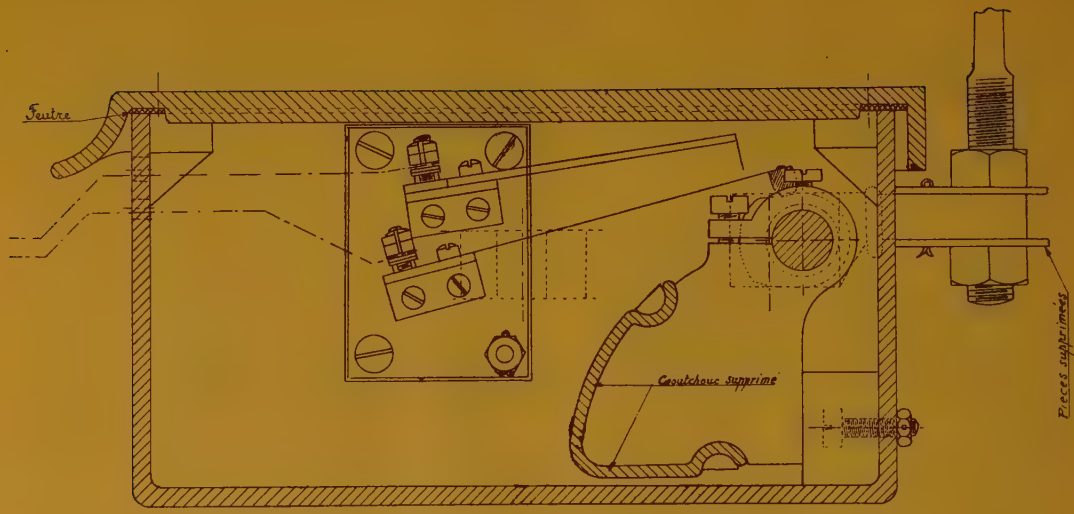
In the case of a train running in the opposite direction it is easy to see that nothing will happen because the tumbler is rubbed by the brush in the direction in which the stop holds it.

§ II. — *French Eastern Railway System.*

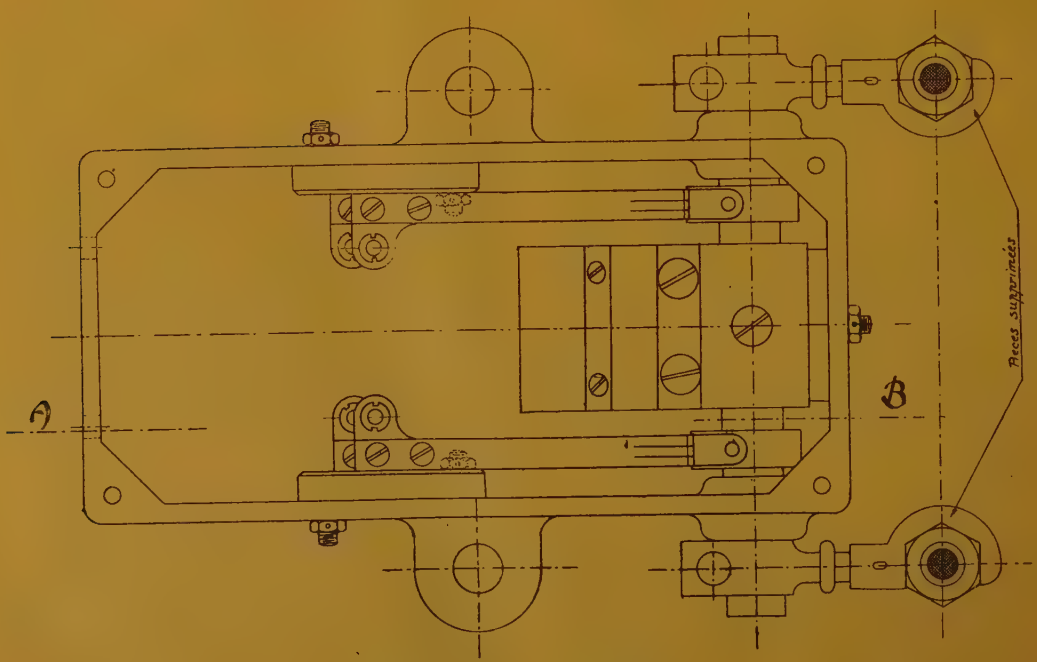
The programme of general conditions to be carried out, as it has been set out by Mr. Maison, is supplemented by the provision of an audible signal to the driver when the signal is at « cleared ». The object of this modification is to show immediately any disarrangement in the working, either of the track apparatus or of that on the locomotive, and to check the alertness of the drivers on passing all signals no matter in what position they may be set.

The audible warning is given to the driver and to the head guard by a whistle (steam hooter) in the case of « danger » signals, and by a bell to the driver only in the case of « clear » signals.

An arrangement has also been adopted to enable the driver, without interfering with the normal working of the apparatus, to mark the speed-indicator diagram, so showing that he had given the signal attention.



Sectional elevation through A. B.



View from above (cover removed).

Fig. 2. — Arrangement of fixed contact tumbler (type 1920).

Explanation of French terms: Feutre = Felt. — Caoutchouc supprimé = Indiarubber not now used.
Pièces supprimées = Pieces not now used.

The application of the system to single tracks has not yet been considered, but this question can easily be solved by a slight modification of the track apparatus.

§ III. — *Paris-Lyons-Mediterranean System.*

The appliances actually in service are the same as those tried in 1913, but the working of the relays, which was effected by a battery carried on the locomotive, is now done by a battery placed on the track; the unlocking of the pneumatic gear of the relay is, however, still effected by the battery carried on the locomotive.

This alteration has been made in order to prevent incorrect operation of the apparatus through the contact-brush touching noninsulated track appliances, which would close the circuit from the brush to the track-rails.

The battery on the track is placed in a cement box arranged close to the signal. It consists of 15 Leclenché (sack) cells connected in series, but the number of cells in action is arranged so as to give a difference of potential of 15 volts between the crocodile and the rail. The maximum output of this battery is about 0.5 amperes.

The battery on the locomotive is carried in a wooden box; it consists of twelve cells (unspillable type) connected in series; the output of the battery is about 1 ampere.

Figure 3 shows diagrammatically the electric connections as actually arranged. They comprise, apart from the details necessary for the proper working of the signal repeating device, a switch Z_2 for making connection with the track battery through the crocodile to the cabin or frame from which the signal is operated, thereby giving the signalman a check both on the position of the signal and the proper working of the battery.

The apparatus on the locomotive is supplemented by a « vigilance lever », operated by the driver and marking the roll or tape of the speed indicator.

§ IV. — *French State Railway System.*

The Cousin, Van Braam, Augereau and French Eastern Type appliances, the trials of which had been decided upon, following the Ministerial circular of the 21 March 1911, have been abandoned.

These systems had serious objections raised against them owing to gauge restrictions and did not adopt themselves to use on electrified sections.

They have been replaced by a modification of the Augereau system which substitutes for the mechanical disengagement, effected by means of the suspended arm striking the rail treadle, a method of disengagement obtained by the influence of Hertzian waves which are produced as the locomotive passes a signal.

This installation comprises a wave transmitter situated in advance of the signal, the receiver being carried on the locomotive.

The transmitting apparatus consists essentially of a Ruhmkorff coil, the primary winding of which comprises an 8-volt battery. One of the poles of this battery is earthed through a contact worked by the signal and the other pole is connected to an insulated rail through two treadles, one placed before the insulated rail and the other beyond it.

The secondary winding of the coil is connected to a breaker and an antenna consisting of a copper wire about 15 m.

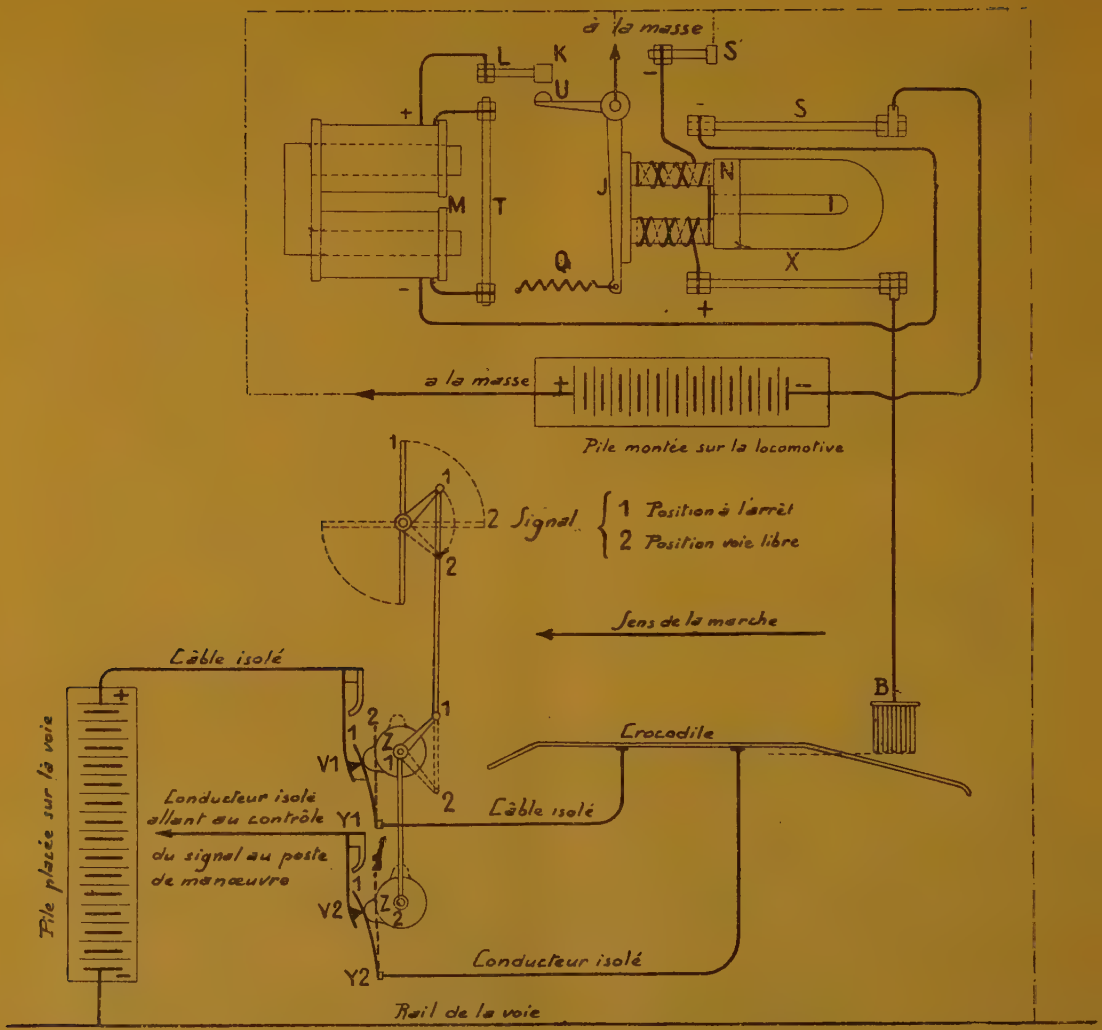


Fig. 3. — Apparatus for indicating and recording stop signals. — Diagram of connections.

Explanation of French terms : A la masse = To engine frame.— Pile montée sur la locomotive = Battery carried on engine.— 1) Position à l'arrêt = Stop position. — 2) Position voie libre = Line clear position. — Sens de la marche = Direction of running. — Câble isolé = Insulated cable. — Pile placée sur la voie. — Battery placed on the track. — Conducteur isolé allant au contrôle du signal au poste de manœuvre = Insulated conductor going to signal control in signal box. — Rail de la voie = Running rail.

(49.2 feet) in length arranged about 2 m. (6 ft. 8 in.) above the ground.

The receiving apparatus consists of a battery, a coherer, an antenna and a solenoid having an iron core. The antenna consists of a copper wire arranged in the

front of the locomotive over the buffer beam and along the side over the platforms.

When the signal is at danger as soon as the first pair of wheels has operated the rear treadle, a current flows through the primary winding of the coil and continues to flow till the treadle beyond the signal is operated. This current, through the action of the Hertzian waves acts on the coherer on the locomotive, the resistance of which diminishes, causing a current to flow through the solenoid with the iron core; the displacement of this core disengages a gear known as the Augereau lock which controls the steam whistle.

Although the trials of this system, carried out on forty signals on the Paris-Chartres line, have given good results, and although the bringing of the system into general use had been decided upon by the French State Railway, the use of these appliances has now been abandoned in favour of the crocodile of the French Northern type; this later decision was adopted with a view to uniformity.

§ V. — *French Midi Railway system.*

The Midi Railway system is continuing the trials which it commenced before the war by means of cab-signalling apparatus similar to that of the French Northern Railway, but since 1914 it has not proceeded with the fitting of the apparatus to more locomotives.

The only modification made since 1913 consists in removing the battery-box from the locomotive and placing it on the track.

To meet the requirements of the Ministerial circular of the 19 November 1919 asking the Railway systems to supplement, by means of detonators, the stop signals, the semaphores as well as the distant disc signals and the junction signals, the French Midi Railway has commenced trials of a detonator-carrier, the working of which is based on the following principles :

1° It is electrically operated by a circuit passing through an insulated rail;

2° It contains a supply of fifty detonators which can be exploded one after the other and is automatic in its action; a single detonator is exploded when the train passes a signal standing at danger.

According to the latest information that we have received, the trials of this appliance have been very satisfactory; out of 2 500 trains that passed the appliance during the first trial period, there were 2 505 detonators exploded, that is to say, there were five unnecessary explosions (more than one detonator being exploded by the same train).

An appliance of the same type, but carrying only twenty detonators is also under trial.

Finally, since the 8 July 1920, there has been on trial on a single track, a new type of detonator-carrying appliance known as the « mutiple hammer » type which will enable an appliance for any desired number of detonators to be built up by means of a series of properly arranged standard parts to suit the particular circumstances.

If the results of these experiments are confirmed by a longer trial, the French Midi Railway System appears to be in favour of definitely adopting the detonator-carriers of this last type instead of the repeating apparatus carried on the locomotives. This solution of the problem, according to a report prepared by Mr. Bleynie, the chief civil engineer, will have the following advantages :

1° As it is not necessary to fit any in-

stallation on the locomotives, it follows that once a signal has been fitted with its detonator-carrier, any train passing will, *ipso facto*, have the benefit of the audible signal;

2° The audible signal will be heard by others than the driver, in particular by the guard of the train, who could take proper action, if the driver should not immediately begin to reduce the speed, either by putting on the brakes or by actuating the alarm bell on the tender;

3° Finally, the vigilance of the driver will be as well maintained by the fact that the explosion of the detonators will be heard by others on the train as it would be by a repeating appliance carried on the locomotive

§ VI. — *The Orleans Railway System.*

The Orleans Railway System has abandoned the trials of the Poublan apparatus referred to in the report of Mr. Maison, and has decided to adopt the crocodile system for repeating the indications of the distant signals in the locomotive cabs.

Trials had been made by means of audible repeating signals (horns) arranged on the track close to the signal and operated electrically by the track circuit. But, as might have been expected, the hearing of the audible signal on the locomotive is not sufficiently certain to be effective in all cases.

§ VII. — *Alsace-Lorraine Railway System.*

Designs and trials on a very limited scale were in progress before the war. They have not been resumed since 1918 and they were only being carried out with a view to finding arrangements that could satisfactorily replace parts of the Van Braam apparatus which had not been found satisfactory in 1911.

The Z. S. apparatus of the Bruchsal Works. — The track apparatus consists of two spring treadles arranged on both sides of the rail about 6 m. (19.5 feet) from the distant signal. These treadles (fig. 7) are directly operated by the signal gear so that they act on the two hanging strikers when the signal is at danger. They are 625 mm. (2 ft. 5/8 in.) in length and are raised 65 mm. (2.5 in.) above the rail level; they encroach on the rolling stock gauge to the extent of 35 mm. (1 3/8 inch); the overlap amounts to 20 mm. (3/4 inch) with regard to the treadles.

Figure 4 shows the arrangement of the apparatus on the locomotive. It consists essentially of an operating gear controlled by two hanging arms connected to the cab-signal apparatus by means of a flexible cable.

The striking gear carried on the locomotive (see fig. 5) consists of two hanging arms with plate springs, carried on two sleeves turning on a fixed shaft; the sleeves carry cams at their ends. In the normal position, at rest, a latch is pressed on to the circumference of the cams by means of a spring. When the cams turn simultaneously, as the result of both arms striking the treadles, the bolt, under the action of the spring, enters the corresponding notch in its cams and causes the apparatus to operate by means of the flexible cable attached to the latch. Two spiral springs fitted at the two ends of the sleeves ensure the return of the hanging arms to their normal position, when the driver brings the latch back to its normal position by means of a lever described below.

The repeating apparatus (fig. 6), placed in the driver's cab, acts as follows :

The flexible cable actuated by the latch of the block apparatus is carried on the cam *a* rotating on the shaft *b*. When both hanging arms have been subjected

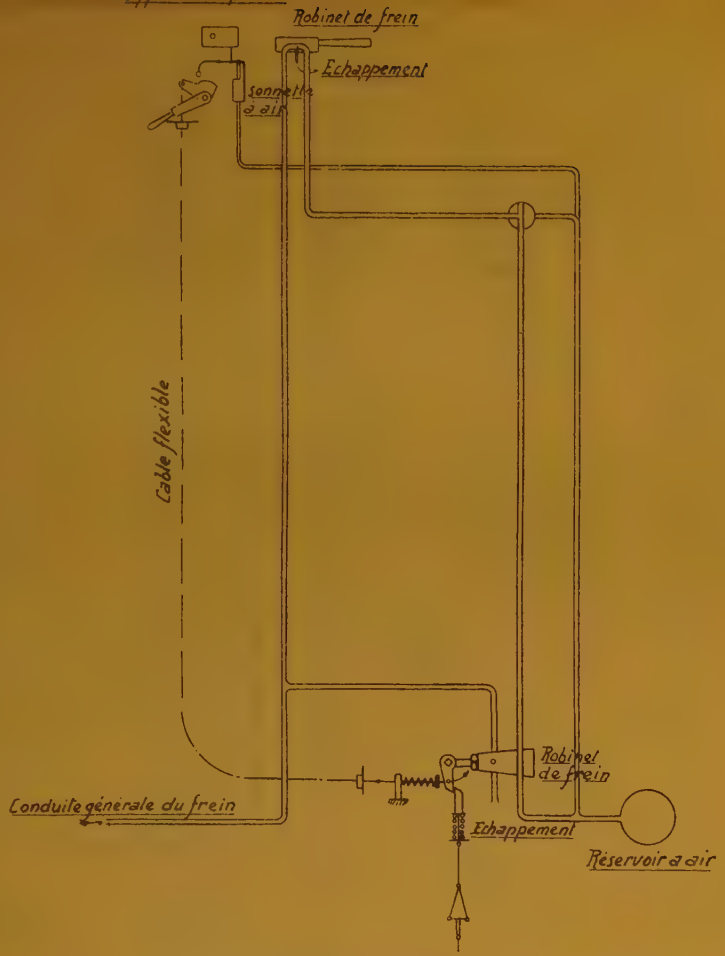


Fig. 4. — Diagram of the Z. S. apparatus of the Bruchsal Works.

Explanation of French terms: Appareil à répétition = Repeating apparatus. — Robinet de frein = Brake valve. — Echappement = Exhaust. — Sonnette à air = Syren. — Câble flexible = Flexible cable. — Conduite générale du frein = Train pipe. — Réservoir à air = Air reservoir.

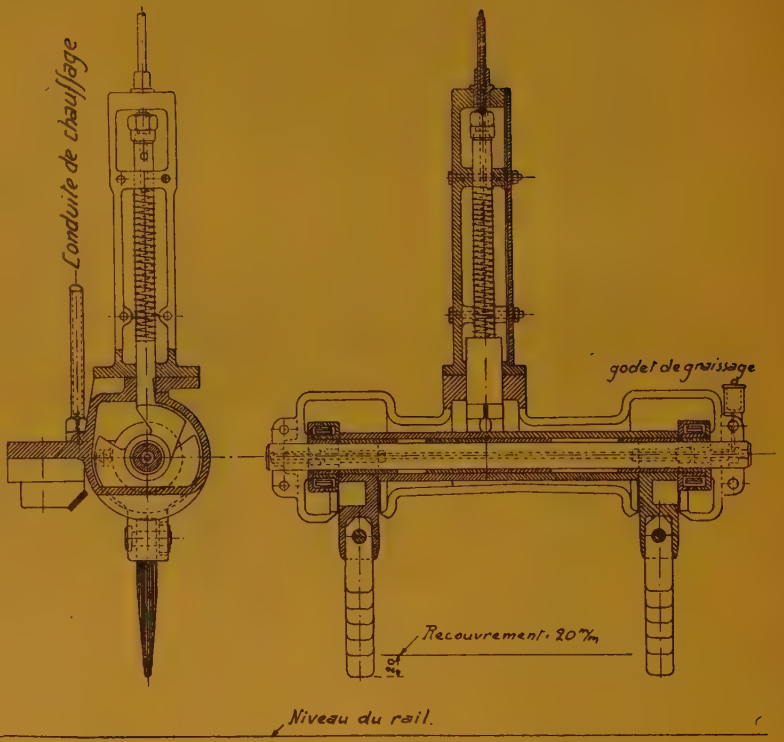


Fig. 5. — Arrangement of control of the Z. S. apparatus.

Explanation of French terms: Conduite de chauffage = Warming pipe. — Godet de graissage = Lubricator. — Recouvrement 20 m/m = Overlap 25/32 inch. — Niveau du rail = Rail level.

to simultaneous shock, the flexible cable transmits the movement for unlocking the latch to the cam *a*. The lever *c* actuated by the cam *a*, acts at its other end on the rod *d*, which operates the valves *e*. Compressed air, supplied through the pipe *i*, enters the whistle *f*. In addition to this a second flexible cable leading to

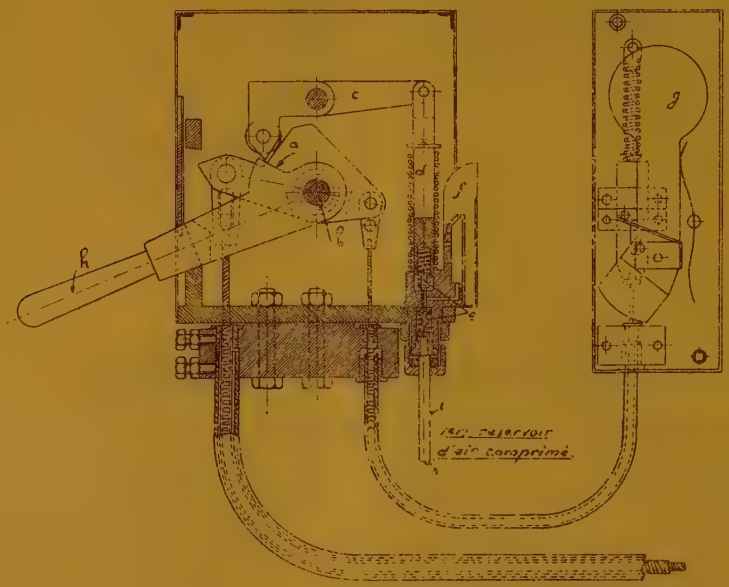


Fig. 6. — Repeating apparatus.

Explanation of French terms : Vers réservoir d'air comprimé = To compressed air reservoir.

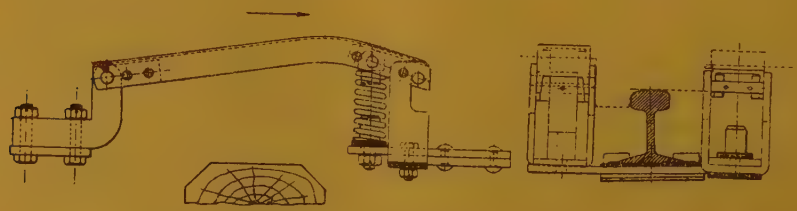


Fig. 7. — Spring treadle.

the visual signal is attached to the cam *a*. The movement of this cam, when the apparatus has worked, is transmitted to the visible signal *g*, which shows behind the glass window. As the result of the displacement of the cam, the level *h*, which was locked by the lever *c*, is released. In order to reset the whole mechanism in its normal position, it is only necessary first to raise the lever *h* and then to restore it to its normal position in which it remains locked.

Results of the trials. — Two locomotives have been fitted with this arrangement which has been put on trial on the

Strasburg-Schizmack line; this line which has a length of 43 km. (26.7 miles) had on it 27 movable treadles. After a period of four years (1911-1915) the apparatus was removed.

Snow and ice have given rise to irregular working of the apparatus either by the binding of the treadle by frozen snow or by the freezing up the hanging arms; heating the pivots of the hanging arms was suggested for overcoming the latter difficulty.

Moreover, the hanging arms, although they had withstood 50 000 shocks without breaking, had become damaged by sudden shocks during the trials. The treadles were also frequently damaged by parts of the rolling stock.

CHAPTER IV.

Critical examination of the list of questions sent to the Railway Administrations.

A supplementary list of questions was sent to the large French Railway Systems with regard to the questions of cab-signals on locomotives.

We will now examine the replies which have been sent to us by Mr. A. Herdner, honorary chief engineer of the French Midi Railway Company, who drew up this supplementary list of questions.

1st question.

Has the experience gained since 1913 led you to modify your views on :

1° *The classes of signals which it is desirable to repeat on the locomotives;*

2° *The general conditions with which this repeating should comply;*

3° *The character of the warning to be given to the driver; visual, audible, or simultaneously visual and audible?*

The Ministerial circular of 19 November 1919 defined the signals, the indications of which should be repeated on the locomotives. These are the distant disc signals, the green and white chequer-pattern indicating signals and the distant signals relating to semaphores, that is to say, the signals which may be run past at speed by the drivers.

From this it follows that the problem does not apply to the Orleans Railway System on which the distant signals are absolute stop signals; however, as we have stated in chapter III, those locomotives of this Railway System which are required to run also on other Railway Systems, will be fitted with repeating apparatus for repeating the distant signals of semaphores.

The general conditions, that the repeating signals on the locomotives should fulfil, are the same as in 1913; nevertheless the French Northern and French Eastern Railways have modified their apparatus in such a manner as to give the driver an audible warning when the distant signal is at « clear ». This new condition appears to us to be essential for enabling the working of the apparatus to be checked : the apparatus works whether the signal is set at danger or at « clear »; if, therefore, a driver passes a signal without observing any action of the repeating apparatus, he should conclude that the apparatus is out of order and consequently should run forward as though the locomotive were not fitted with a repeating apparatus.

If, however, the apparatus should work at the next signal, he may then assume that it is the track apparatus of the first signal that is out of order and he should

in such cases advise the permanent way staff at his first stopping place of the defects which he has noticed.

The opinions given by the Railway Companies relating to the form to be given to a cab-signal have not varied : namely, that it is the audible signal that should be adopted. For indicating a signal standing at danger the warning should be sufficiently loud for it to be able to be heard both by the driver and the guard of the train, but in the case of a signal standing at line-clear, it is sufficient that the driver alone should receive the warning.

The appliances of the French Northern and of the French Eastern Railway Systems are, moreover, operated in such a manner as to mark on the recording strip the indications given by the repeating apparatus, as well as to record the attention given by the driver to signals which he has found set against him.

2nd question.

Has the experience obtained since 1913 led you :

1° *To abandon the use of the appliances described or mentioned in your reply of 1913, adopted by you previous to that date, or of which you were then engaged in making trials?*

If in the affirmative, please say which, and give reasons for abandoning them.

2° *To effect important modifications in the apparatus described or mentioned in your reply of 1913, adopted by you before that date, or of which you were then engaged in making trials?*

If in the affirmative, please state the nature of these modifications, what is their object, and to what extent this object has so far been attained.

3° *To put on trial, or to adopt after satisfactory trials apparatus not described in your reply of 1913?*

In chapter III we have given a summary of the particulars which have been supplied by the Railway Companies with regard to this question.

It follows from these replies that the crocodile type of apparatus is that which has been generally adopted, with some differences of detail, on all the Railway Systems except that of the French Midi Railway. The other appliances tried and particularly the Cousin, Van Braam and Augereau appliances tested on the French State Railways, and the Poublan apparatus tested on the Orleans Railway System have been abandoned.

The batteries necessary to the working of the warning portion of the crocodile gear are always placed on the ground close to the signal, an arrangement which enables the working condition of the batteries to be checked easily at the cabin or frame from which the signal is worked.

The disadvantage which Mr. Maison has pointed out relating to the failures due to frost, or to snow covering the smooth surface of the crocodile appear to have been completely overcome by means of the use of the Colas apparatus.

This contact is rendered frost and snow proof by the spreading of paraffin contained inside the apparatus; with this object the contact surface is drilled with a series of holes to allow the paraffin to ooze out.

The contact brush of the French Northern Railway System consists now of special steel wires with a view to obtaining a longer life.

The French Midi Railway System has on trial a detonator placing apparatus capable of holding a large number of detonators (20 to 50) so arranged that a single detonator is exploded when the train passes a distant signal standing at danger.

The results of these trials have been very satisfactory; so much so that this Railway Company is questioning whether the desired results cannot be better obtained by the use of detonator placing apparatus rather than by cab-signalling.

In a report which has been communicated to us, Mr. Jouguet, chief engineer, asks, in relation to this subject, « why distant signals should of necessity be repeated *on the locomotive?*

« It is the transmission from the track to the locomotive that introduces all the difficulties into the problem. Why should not the audible repeater be sufficient, as would appear to be admitted by the official communication dated the 30 August 1913? We would simply say » he adds « that this solution of the question appears to be sufficient ».

This opinion is also shared by Mr. Bleynie, engineer in chief, in his report dated 22 January 1920.

We think it advisable to note, in this connection, that experiments made in Belgium with similar appliances, due to the French inventor, Cousin, and to a Belgian inventor, Mautsch, have shown during the two years over which the experiments have extended that notwithstanding the apparatus being well made and carefully maintained, fairly frequent cases of failure of the detonators occurred as well as breakage and disarrangement of wires and the premature exhaustion of the store of detonators; all these troubles militate against safe working.

In a very complete article relating to signals for giving warning in fog (1) Mr. Weissenbruch adds :

It might have been possible to reduce the number of these failures by using continuous current, insulated wire and metal detonators. However, nothwithstanding the greater cost, nothing could have been done to avoid the dangerous anomaly that there was no means of warning the driver in the event of the signalman having forgotten to put his apparatus into action in foggy weather. In such a case the absence of the noise of the detonator might make him think that the track was clear. And, moreover, it would be impossible to maintain detonator placing machines in constant use at all times and on all main lines of a Railway Company.

Perhaps the trials commenced in 1920 on the French Midi Railway System may have given more favourable results. We hope that the supplementary information which will be supplied on this subject in the course of the discussion of the question in Rome will enable the members of the Congress to arrive at a definite opinion on the subject of this class of repetition for signals other than absolute stop signals.

3rd question.

Has the experience acquired since the date of your reply to the detailed list of questions of 1913 led you to make any alterations in the replies made to questions 5 to 13 of the said list of questions?

Since 1914 a very great step forward has been made in France with a view to the repeating of signals in the cabs of locomotives.

On the French Northern Railway all

(1) *Bulletin of the International Railway Association* for April 1920.

locomotives, except shunting locomotives, are fitted with repeating apparatus. Fixed contacts to the number of 3 800 are fitted on this Railway System on a length of track of 3 803 km. (2 360 miles).

The same is the case on the French Eastern, the Paris-Lyons-Mediterranean and the French State Railways; all locomotives running with trains are in course of being fitted with cab-signals and the equipment of the main lines of these Railways is in progress.

Contrary to the opinion expressed in 1914, the present tendency, on the French Northern and French Eastern Railway Systems consists in warning the driver on passing signals at danger and at line-clear by means of different audible signals.

Under the 2nd question we have given the reasons which, in our opinion, tend to favour this solution.

So far as concerns the 10th question relating to running on single tracks, we have mentioned that the French Northern Railway System uses a special crocodile fitted with a tumbler in such a manner that it operates for only one direction of running.

Table III of Mr. Maison's report should be replaced by the table below so far as the French Northern and the French Eastern Railway Systems are concerned, these being the only ones that have supplied particulars on the subject of the actual cost of the repeating apparatus that they have in use :

—	*French Northern.*	*French Eastern.*
Cost per locomotive . . .	1 000 fr.	2 500 fr.
Cost per signal.	1 200 fr.	1 400 fr.

No modification is necessary with regard to the replies to questions 7, 8, 9, 11 and 12 of the list of questions of 1913.

CHAPTER V.

Conclusions.

It follows from the matter set forth in this supplementary report that the conclusions proposed by Mr. Maison may be retained in their entirety, except in so far as Nos. 3 and 7 which we propose to modify as follows :

3° *It should be so devised so as to prevent the driver becoming inattentive and with this object the apparatus should be made to record the position of all the signals passed; with this object it is advisable that this should be shown on the paper of the speed recorder.*

The warning should be given in a different manner for signals at danger and at line-clear. Finally, it is advisable, in the interest of safety, to arrange a check on the attention of the driver by requiring this employee to perform a small movement, easy of recording, when he sees a signal standing at danger.

7° *The repeating of signals in the cabs of locomotives may be carried out by electrically or mechanically driven apparatus. In France the crocodile type of apparatus is preferred and it is capable of application to single tracks without difficulty. It can also be applied equally well to electrified tracks.*

SECTION II.

Speed Recording.

CHAPTER VI.

State of the question in France.

Mr. Maison in his report states that the greater number of locomotives on the

great French Railway Systems had already, in 1914, been fitted with an indicating and recording apparatus. The percentage so fitted was 79.2 and, as the number of shunting locomotives amounted to from 7 to 8 % of the total in use, it may be assumed that in 1916 — the limiting date fixed by the Ministerial decision of 31 January 1912 — the work of equipment of all the locomotives running on the line would have been entirely completed.

The war, of course, interrupted this work; but it was resumed in 1919. The following table shows the position in 1920 :

RAILWAY COMPANY.	Locomotives fitted with speed indicating and recording apparatus.		
	Number of passenger locomotives.	Number of goods locomotives.	Total number of locomotives.
French Northern	1 234	527	1 761
French Eastern	...	...	2 181 (1)
Paris-Lyons-Mediterranean	...	...	3 140
French State	..	...	2 783
French Midi	...	...	908
Orleans	1 185	697	1 882
Total	2 429	1 224	12 655

(1) Including 150 locomotives fitted with non-recording apparatus.

The increase on the total figure for 1914 is therefore about 8 %.

The work of equipping the 7 to 8 % of locomotives that were still without this apparatus has consequently probably been completed at the present time.

The Alsace-Lorraine Railway System uses the Hausshaelter and Deuta appliances. As a general rule all the locomotives of this Railway System, except those used exclusively for shunting, are fitted with speed indicators. The following table shows the numbers of locomotives so equipped.

TYPE OF APPARATUS.	Number of locomotives fitted with recording apparatus.		
	Passenger locomotives.	Goods locomotives.	Total.
Hausshaelter	337	257	594
Deuta	100	324	424
Total	437	581	1 018

CHAPTER VII.

Speed-recording appliances.

No modification has been introduced since 1914 into the speed-recorders described in Mr. Maison's report.

We will confine ourselves therefore to giving a description of the working of the Deuta apparatus, shown in figure 8, in use on the Alsace-Lorraine Railway System.

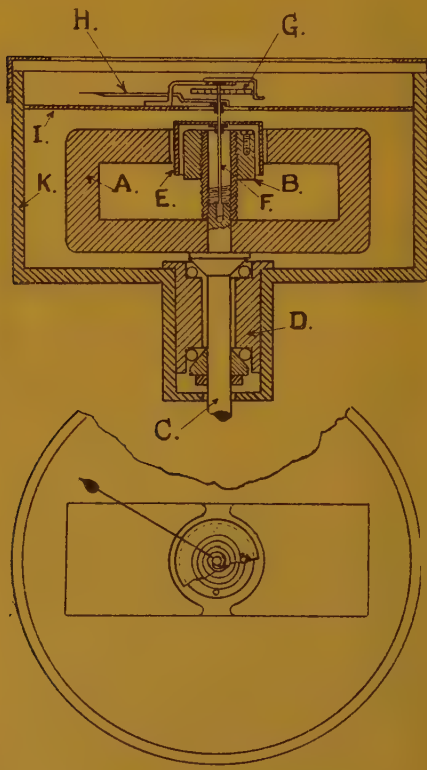


Fig. 8. — Deuta apparatus.

Deuta Apparatus. — The apparatus is based on the fact that a short-circuited armature placed in a revolving magnetic field, itself receives a rotational moment proportional to the velocity of rotation of the field.

The permanent magnet *a*, of which the air space between the two poles and the cylinder *b* is only 1 mm. (3/64 inch), turns with the shaft *c*. The rotational movement of the shaft *c* is produced by means of a flexible-drive transmission gear, itself driven from one of the locomotive wheels. Its rotational movement is therefore proportional to the speed of running of the locomotive. The rotation of the magnet causes currents to flow in the body of the armature *e* which tend to cause it to turn. This movement is opposed by a spring, fixed at one end to one of the supports of the speed-recorder case, and at the other to the shaft of the armature. This shaft carries a hand *h*, which, consequently, according to the speed, occupies the position in which there is equilibrium between the tension of the spring *g* and the rotational moment due to the magnet. When the locomotive is at rest the spring returns the hand to zero on the scale. The dial is graduated from 0 to 120 km. (0 to 74.6 miles) per hour for forward running, and from 0 to 60 km. (0 to 37.3 miles) per hour for running backwards.

CHAPTER VIII.

Conclusion relating to speed recording.

It follows from the preceding considerations that the conclusions in Mr. Maison's report are entirely correct and may be submitted without alteration for the approval of the Rome Congress in 1922.

[656 .211]

REPORT No. 2

(all countries, except those using the English language)

ON THE QUESTION OF TERMINAL STATIONS FOR PASSENGERS (SUBJECT IX FOR DISCUSSION AT THE NINTH CONGRESS OF THE INTERNATIONAL RAILWAY ASSOCIATION), (1)

By Louis MACCALLINI,
ENGINEER,
PRINCIPAL INSPECTOR TO THE ITALIAN STATE RAILWAYS.

Figs. 1 to 7, pp. 555 to 567.

It is well known that practical difficulties are experienced in large terminal passenger stations and through stations signalled as terminal stations, because of the lack of sufficient means designed to ensure rapidity and independence of movement in the clearing and making the best use of the arrival lines, stabling and re-forming of empty rolling-stock, and the attaching and detaching of locomotives. In view of these difficulties which are very considerable in nearly all large stations, the problem has arisen as to the most practical arrangements, and better use of the accommodation, so far as shunting operations are concerned, in order both to reduce the latter and to render them more independent, especially in view of the increasing number of passenger trains and the ever increasingly complicated exigencies of their formation, an importance which rightly calls for the particular attention of railway administrators.

Every arrangement tending to simplify and reduce the movements in question helps to increase the capacity of the stations as well as the regularity of the service, and effects equally the running of the trains. This problem is therefore very appropriately dealt with, for the first time, at the ninth Congress of the International Railway Association, as a special question. Previously it has formed part of the more general question of « Large Stations » which at the preceding Congress formed the subject of question IX.

Our questionnaire was addressed to thirty-five administrations, sixteen of which have forwarded us definite replies, *viz.* :

Belgium . . .	State Railways.
Denmark . .	State Railways.
Spain . . .	Medina del Campo-Salamanca Railway.
—	Northern Railway.
—	Medina del Campo-Zamora Railway.

(1) This question runs as follows : « Arrangements for reducing the number of movements of locomotives and empty rolling stock at passenger terminal stations. »

France . . .	State Railways.
—	Est Railway.
—	Paris-Orleans Railway.
—	Paris - Lyons - Mediterranean Railway.
—	Alsace-Lorraine Railway.
Italy	State Railways.
Norway . . .	State Railways.
Holland . . .	Holland Railway.
Portugal . . .	State Railways.
Sweden . . .	State Railways.
Switzerland .	Federal Railways.

We give below the various sections of the questionnaire with explanatory remarks and a summary of the information given by the administrations.

QUESTION 1. — *What are the most important and characteristic terminal passenger stations on your system?*

The following are the stations which we have specially considered. In several cases, however, it must be remarked that we did not receive plans :

Belgium : Antwerp-Central, Antwerp-South, Brussels-North, Brussels-South, Liége;

Denmark : Copenhagen;

Spain : Barcelona, Madrid, Salamanca, Valencia;

France : Lyons-Perrache, Marseilles-S. Ch., Metz, Orleans, Pantin, Paris-P.-L.-M., Paris-St. Lazare, Paris-Est (present, and with proposed extensions), Paris-Austerlitz, Paris-Quai-d'Orsay, Strasburg, Tours;

Italy : Bologna, Genoa-P.-P., Naples (present, and with proposed extension), Milan-C. (present and future), Rome-T., Turin-P.-N.;

Norway : Christiania, East and West;

Holland : Amsterdam-Central, Rotterdam;

Portugal : Oporto;

Switzerland : Basle, Zurich.

In accordance with the information received from the various administrations, our report deals with the present state of their stations, or the installations which, as in the case of the new stations at Milan and Naples, are already in course of construction. No administration has furnished us with information regarding projects for new stations.

QUESTION 2. — *Are these terminal stations or through stations, signalled as terminal stations?*

There is need for a clearer definition of the distinction made in this question, by more clearly defining terminal stations, *i. e.* those which serve as terminating stations for the whole or a part of the trains which arrive there, whether as dead end stations or through stations, from the point of view of their facilities or whether as terminal stations for the reversing of trains from the point of view of their system of working.

a) Dead end stations, which are termini for all trains, or termini for certain trains, and reversing stations for others :

Belgium : Antwerp-North, Antwerp-South, Brussels-North, Brussels-South;

Spain : Barcelona, Madrid, Valencia;

France : Marseilles, Orléans, Paris-P.-L.-M., Paris-St Lazare, Paris-Est, Paris-Quai d'Orsay, Tours;

Italy : Naples, Milan (new), Rome-T., Turin-P.-N.;

Norway : Christiania, East and West;

Fig. 1. — Enlargement of Paris-Est Station. — Plan of proposed arrangements on the level of the tracks.

Holland : Rotterdam;
Portugal : Oporto;

b) Through Stations, signalled as terminal stations which are termini for certain trains, or reversing stations for others :

Denmark : Copenhagen;
Spain : Salamanca;
France : Lyons-Perrache, Metz, Pantin, Paris-Austerlitz, Strasbourg;
Italy : Bologna, Milan-C.;
Netherlands : Amsterdam-C.;
Switzerland : Basle.

c) Dead end and through stations, signalled as terminal stations which are termini for certain trains :

Belgium : Liége;
Italy : Genoa-P. C.

Question 3. — *From the point of view of the station facilities is the main-line service completely separated from the suburban service, and in what manner?*

The separation of the lines used respectively for the suburban and main-line services, each of which has special characteristics and requirements, was approved in principle by the Congress of 1910. In this connection it may be noted that as regards the suburban service, where arrivals and departures are very frequent, the problem of the reduction and simplification of the movements is of vital importance.

In the case of those stations which we have examined, and in which the suburban service is important, no progress seems to have been effected as regards separating the two services; the only station having sets of lines used exclusively for suburban traffic is the St. Lazare station at Paris. Among the stations in course of re-arrangement may be mentioned that at Naples, where the Metropolitan service will be on special through lines situated under ground and completely separated from the rest.

In a number of cases, however, according to requirements and the suitability of the lay-outs, certain lines are exclusively reserved for suburban traffic at certain hours of the day. On the same principle, in stations where there are both electric and steam locomotive services, the electrified lines are separate from the others.

Question 4. — *What is the number, per twenty-four hours, of trains in normal service at periods of maximum traffic, and how many arrival and departure platforms receive and despatch the trains? What are the shortest intervals between trains arriving at or leaving the same platform?*

This information is indispensable for determining for each station the extent and arrangement of the lay-outs in relation to the rapidity of movement of trains. It is evident that the necessity of reducing and simplifying the workings is most felt in cases where, because of the impossibility of further extensions, it is necessary to utilise the lines to the highest possible degree in view of the short intervals between successive trains.

Thus, in the case of new stations the number of platform lines and the capacity of the shunting lines are determined by the volume of the traffic and the use they may be put to taking into consideration the lay-out and nature of the service.

The information supplied to us on this question does not give an exact idea of the capacity of each station, because under

present conditions there is a reduced traffic on all railways. Further, as the information given is not sufficiently homogeneous to admit of comparison, it has not been possible to arrive at any conclusions.

QUESTION 5. — *Have you adopted, or do you intend to adopt, pear shaped or continuous loops, triangles, or other such arrangements, with a view to reducing to a minimum the movements of engines and empty vehicles.*

Where there is a sufficiently large suburban traffic it would always be advisable to adopt such arrangements of the lines as would allow of the trains being despatched again, immediately after their arrival, without modifying their composition or changing the position of the engine. This takes place when the lines are provided with pear shaped or continuous loops in such a way that it is possible to reverse the trains without shunting or changing engines. But lines with loops, as adopted for some time past in America, are not found in the stations which we have examined, neither for suburban nor for main-line traffic; and the Administrations in reply to our inquiries have stated that they have not adopted the loop system, and do not propose to do so for the present.

For the new station at Milan, lines with loops will be provided for the independent movements of locomotives between the two sides of the station and the depot.

The arrangement of lines with triangle also makes it possible to reverse trains without altering their formation; it is much less convenient than the loop arrangement, and is only used in stations to reverse the engines.

QUESTION 6. — *Are the arrival and departure platform lines used indiscrimi-*

Fig. 2. — Paris-St. Lazare-Station.

Fig. 3. — Paris-E

nately or kept specially for these purposes?

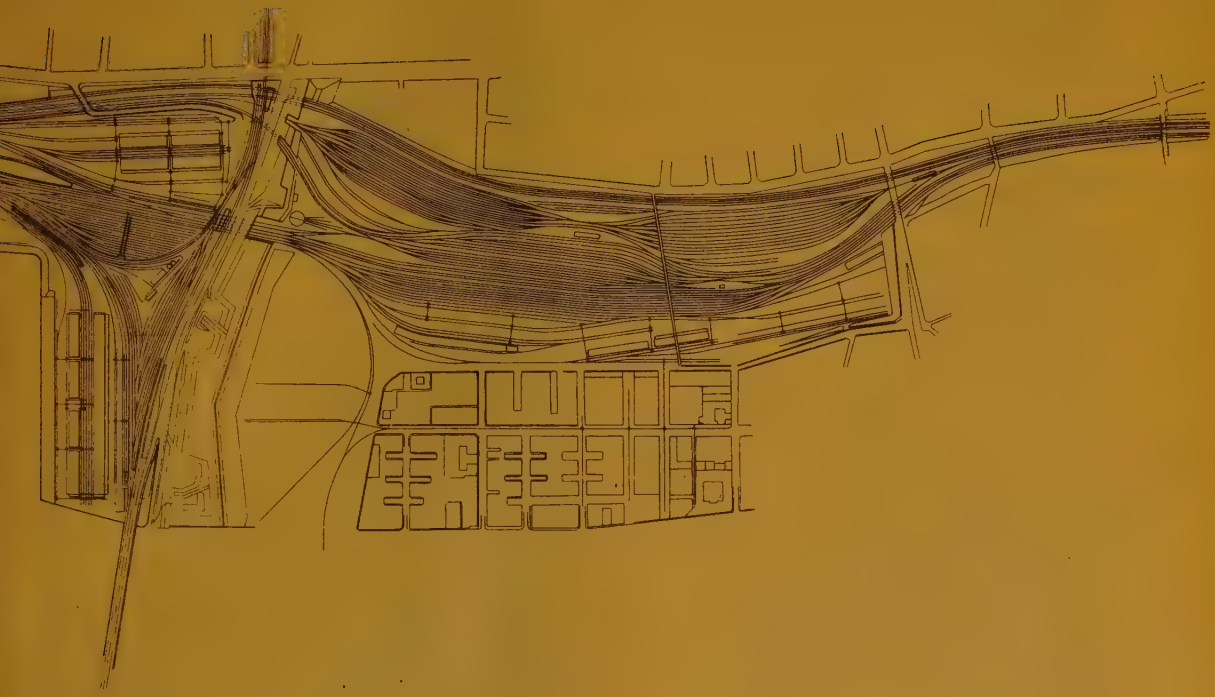
The complete separation of the arrival and departure lines, as generally adopted on the German railways, is convenient for the public, but imposes additional restrictions in shunting of vehicles, and does not allow of the full use of the station lay-outs.

In the majority of the stations examined, the platform lines are for common use, but in practice an attempt is made to assign to each a definite service, by reserving for the arrival and departure of trains the lines by the side of the main corresponding arrival or departure line in each direction and by using the middle lines for ordinary purposes.

In general, in the working of the largest stations used by several companies, an attempt is made to allocate a group of platform tracks to each Company and to apply the above principle to each group.

In all cases the number of definitely allocated specialised lines is strictly limited.

QUESTION 7. — *What lay-outs are provided for changing, reversing the position of, or detaching engines? Are there any tracks at the ends of the platforms, or central tracks between the platform lines, connected by points to the ends of the*



M. (passenger) Station.

latter? Or, especially in the case of high and low level stations, are there any turntables, traversers, or other appliances.

The uncoupling of engines on arrival, placing them at the head of their trains for departure, or changing then from one end to the other, does not usually present any difficulty in through stations with connections at each end. In these stations the engines join the trains or return to the depot or shed by means of a free line, and lie-by lines suitably situated facilitate their movements.

In terminal stations the difficulties to be overcome from the point of view of the lay-outs are, on the contrary, considerable. It is, however, of great importance to uncouple the engines immediately on their arrival so as to transfer them at once to the other end of the station, especially when they are worked on suburban traffic and are required to start out again without delay. The lay-outs devised with this object are such as to give communication between two or more lines at the end of the platforms by means of a system of cross-overs (either single or scissors), or by turn-tables and traversers. These lay-outs are fairly satisfactory, especially in high and low level stations where the platform at the end of the rails is not used by passengers; but generally they are incon-

Fig. 4. — Brussels-Midi (South) Station.

venient as they prevent the use by the public of the most accessible and convenient part of the platform and by requiring a greater length of platform.

A central track between two platform lines, connected to the latter by cross-overs at the ends, greatly facilitates the changing of engines, and is at the same time very useful for shunting, and for holding locomotives and empty vehicles.

The arrangements to which we have just referred are to be found in several instances in the stations whose plans we have examined. The use of scissor cross-overs is becoming general in stations in which the platforms are sufficiently long to avoid the backing of trains from which it is necessary to detach the engine. Various administrations (*e. g.* the Paris-Orleans Company of France, at the station at Tours) propose to instal them at their stations on tracks which do not already possess them.

The solution of having central tracks between the platform lines, and the use of turn-tables and traversers for the engines, is of less wide application.

At the Paris-Austerlitz station a central track is used for the changing of the electric locomotives; traversers are used at the Paris-Luxemburg and Paris-Bastille stations for transferring the electric locomotives and tenders.

Tracks at the end of the platforms, which allow of placing engines in readiness, are installed in several large stations. This arrangement, also used for holding passenger-carriages to be used in the make-up of trains, is very useful, particularly when the station has no other special lie-by line, and when it is situated at some distance from the depot. Tracks at the end of the platforms are being considered in the plans for the re-arrangement of certain large stations. The

Fig. 5. — Zurich-Station.

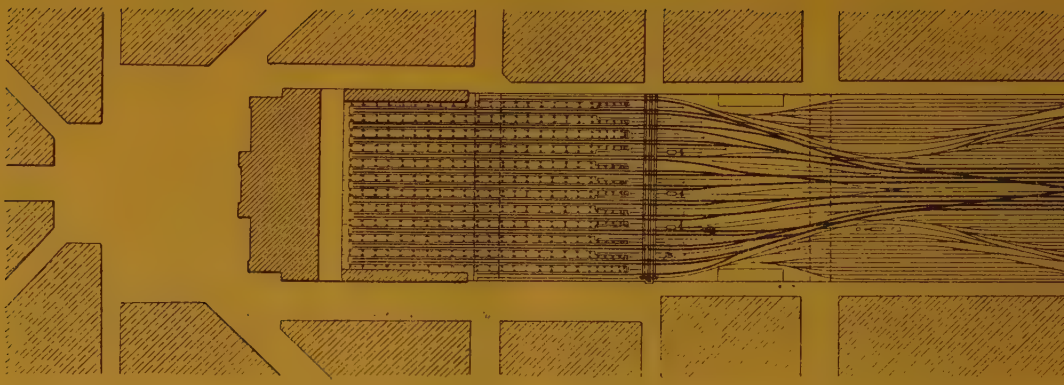


Fig. 6. — New Milan-Station : Floor on the level of the passenger tracks. — 1 = Wago

administrations replying do not suggest any other means for a better solution of the problem in question.

QUESTION 8. — *What are the lay-outs and arrangements provided for attaching and detaching vehicles?*

It is particularly a question of the movements necessary for attaching on vehicles (special carriages, luggage vans, et.), to trains or detaching them from trains which are standing on platform lines; or for completing the make-up of empty trains after being put into position.

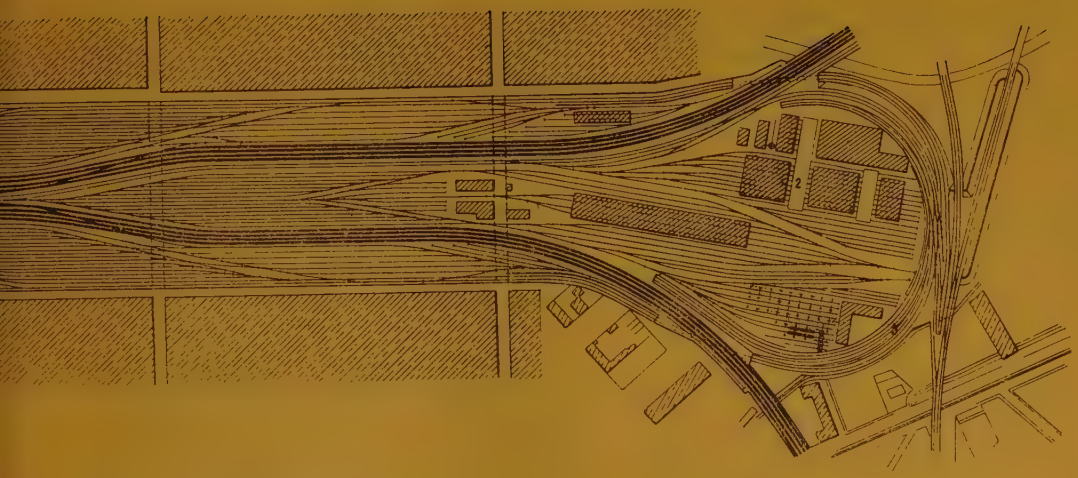
As an almost general rule in large stations there have been installed for this purpose electric traversers serving all the roads, and the use of turn-tables is being entirely done away with.

For attaching or detaching vehicles by means of an engine we find various lay-outs, *e. g.* special central tracks between the platform lines; outside tracks; or standing tracks at the ends of the platforms. These tracks are connected with the platform lines in such a way as to render the movements as rapid as possible.

QUESTION 9. — *What lay-outs and arrangements are provided for the sorting of empty rolling-stock, its marshalling and making up? Where are the groups of sidings placed for sorting empty trains and for making up trains :*

1° *In the passenger station itself :*
   a) *between the main tracks, alongside them, or on a different level from these tracks?* b) *on the arrival or departure side?*
2° *Outside the passenger station in special yards?*
3° *In such a way that the trains arriving can be brought directly on to the sorting sidings, either by continuing in the same direction (i. e. beyond the platforms), or by backing?*

In the case of large passenger-stations



— 2 = Electric traction installations. — 3 = Loop to permit the movement of the engines.

the question of the provision of adequate lay-outs suitably placed for the sorting of empty rolling-stock, its making-up and cleaning, is of great importance whether from the point of view of facilitating and reducing shunting, or from the general standpoint of efficiency of working.

The sorting and making up sidings are really the lungs of the large stations; they determine its capacity for coping with traffic, and enable trains to be dealt with quickly and so avoid congestion.

This question should receive the careful consideration of railway administrations.

The sorting sidings are generally approachable from either end; they are provided with a draw-out track and completed by small dead-end groups used for the making-up of empty trains. They are placed, when possible, in the passenger stations, or quite close to the stations, so as to minimise the time taken in transferring the trains to them. Some of them however are at some distance from the stations, determined by topographical conditions and the space available for the necessary lay-outs. In the first case it is obviously preferable to place them between the lines which enter the station, so as to give direct communication between the platform lines and the sorting sidings without crossing the main lines; but these desirable conditions cannot always be realised if the best use is to be made of the available ground, which is often somewhat limited, especially in the older stations; and in this case the sorting lines have to be placed either wholly or in part on either side of the main lines in one or two groups, connected by cross-over roads.

In cases where these sorting groups are at a distance from the station, they are placed in independent yards separate from the passenger station.

Where there is a single group of sorting sidings with separate platform lines for arrival and departure, it is obviously preferable to place it on the arrival side to render freeer the movement of the empty trains. Finally, in some cases, to secure the absolute independence of the main lines,

the sorting sidings may be placed at a different level so as to avoid crossing the main lines; but this solution involves heavy expenditure on lay-out, and causes many difficulties of working because of the unavoidable gradients of the connecting lines. In any case, whatever be the position of the sorting sidings in relation to the platform lines, the establishment of direct and easy communication between them for holding and placing in position empty trains is undoubtedly of the greatest importance.

The transfer of the trains from the sorting sidings may be effected by simply running forward, backing, or running in the reverse direction. The disposal of trains by running on to sorting sidings which form a continuation of platform lines by engines of the arriving trains and in the direction of their arrival is naturally preferable. Disposal by backing is also convenient when it can be effected by the engines of the arriving trains to sorting sidings which are connected to platform lines : but disposal by running in the reverse direction by means of a draw-out track, has to be effected with shunting engines under the least favourable conditions from the point of view of rapidity and simplicity of movement.

We consider that lay-outs which involve a double movement for the splitting-up and the putting into position of empty trains should always be avoided, and that no consideration of space, safety or economy can justify them.

We have, however, found several such in use in the stations examined, and there are still such sorting groups to be found in current proposals for the re-arrangement of stations. We think that in this case sight has been lost of the problem of the reduction and simplification of movements, and that consequently the problem is aptly put forward at the present moment with a view to new suggestions.

Finally to avoid moving empty trains after their splitting up, in order to transfer them from the arrival to the departure side, it may be advisable to separate the platform lines into groups of three lines, and to connect each group to small sorting groups of sidings; but this solution necessitas the frequent passage of the shunting engine from one set of sidings to the other.

The stations of which we have received plans show great variation, and from an examination of the methods adopted it is scarcely possible to arrive at any general formula for the solution of the problem.

Some sorting sidings are in the station itself or quite near, others are some distance away; some are by the platform lines, either laterally, or continuing in the same or in the opposite direction; there are others which are situated by the main lines entering the station at either end, or between these lines.

A good arrangement which may be referred to is that adopted in the new station at Milan. The platform lines there are divided into three groups, and each group is accompanied by a group of sorting sidings. The sorting lines of the middle group, placed between the main lines, are the most extensive, and can be used for all the platform lines.

Question 10. — *How are the sorting sidings connected with platform lines? Have you laid down large double cross-overs at the ends of the stations? Are the special sorting yards connected with the chief station by separate lines, and what is the length of the latter? Have you provided storage lines between detached sorting sidings and the*

groups of platform lines for the temporary accomodation of empty trains?

This question is closely connected with the preceding one.

In principle, to regulate shunting better without interfering with the running of the trains, it is necessary that the sorting sidings should be connected with the platform lines in such a way that the shunting of empty trains shall not interfere with the main lines, and that all the sorting sidings of the group should be directly connected with the platform lines which they serve.

In the plans of the stations examined we have found a general tendency to use large double cross-overs giving the maximum possible communication between the arrival lines at the station and the platform lines, and between the latter and the sorting sidings.

Sorting sidings placed at a distance from stations are connected with the platform lines by the main lines or by special direct auxiliary lines; and, in general, we have found that almost all administrations have endeavoured to secure communication between the platform lines and the sorting sidings as far as possible by means of independent lines.

Lie-by lines for the temporary accommodation of empty trains are laid down as continuations of platform lines so that trains may be moved there immediately after their arrival in cases where the sorting sidings are away from the station and when empty trains in moving into the lie-by lines make use of the main lines at any point.

QUESTION 11. — *Is the shunting of empty trains done with the engines of the trains or with shunting engines :*

a) *For the sorting of the trains on arrival;*

b) *For bringing the trains to the departure platforms?*

Use is made of the engines of the trains or shunting engines according to the position of the sorting lines in relation to the platform lines.

As an almost general rule, empty trains are taken out by the engines of the trains themselves, and shunting engines are used to bring trains to the departure platforms.

QUESTION 12. — *What arrangements are adopted for mails, luggage, and parcels carried by passenger trains?*

The arrangements for dealing with luggage do not affect the shunting operations. These arrangements are placed in the station building, and very little shunting is necessary to facilitate the loading and unloading of parcel vans.

As regards shunting in the case of mail and parcel vans, careful consideration should be given to the question of special lay-out for detaching vehicles from or attaching them to trains to ensure their loading and unloading with the maximum speed and the minimum shunting. In the stations examined, lines parallel to the platform lines, on the same level as the latter and near the central building of the station, are generally reserved for the postal and parcels service. These lines are connected with the platform lines either by electric traverser or by points.

In some stations, *e. g.* the P. L. M. passenger station at Paris, there is a postal siding for the loading of the mail-vans; others, *e. g.* Paris-St. Lazare, have central lines between the platform lines to accomodate waiting mail-vans.

In the largest stations the parcels service is divided into two separate branches, arrivals and departures.

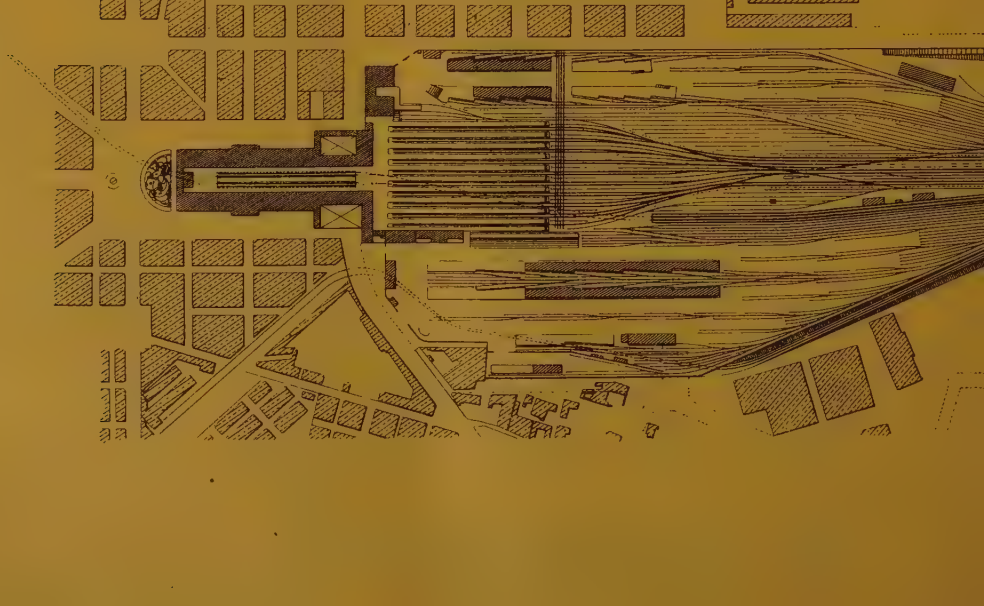


Fig. 7. — E

ment of Naples Station.

Luggage and parcels to be sent by passenger train are loaded in the luggage vans of trains about to start or waiting on platform lines, whither they are brought from the parcel offices on the same level by hand-barrows, three-wheeled trucks, or electric-motor tractors. In stations where luggage and parcels are received underground, the packages are brought up to the platform by lifts or escalators, and conveyed to the vans by motor tractors.

At the St. Lazare station Paris, the parcel service has an upper floor on the level of the street and a lower one on the level of the tracks; the junction is made by means of wagon-lifts.

In the new station at Milan the post and parcel installations are on the level of the street, lower than that of the tracks, and the manœuvres are made either by independent lines which reach the level of the upper lines at a certain point, or by means of a wagon-lift and traverser.

QUESTION 13. — *In what position in the train do you place the mail-van and the luggage and parcels vans? Have you special lines for accommodating, loading and unloading these vehicles, and how do you regulate shunting on these lines?*

This question completes the preceding one. The position of the luggage and parcels vans in the trains greatly affects the shunting operations in the station, and in general must be determined by the accomodation provided. Thus, in dead-end stations, two vans, one at each end of the train, avoids shunting.

From the replies we have received, it appears that mail-vans, luggage and parcels vans are placed at the front, in the middle, or at the rear of trains, in accordance with the rules regarding the composition of trains drawn up by each administration, according to local conditions, with a view to facilitating as far as possible the attaching and detaching of these vans.

The loading and unloading of these vehicles is done while the train is standing at the platform; but in some stations there are, as we have already said, central lines between the platform lines, or adjacent lines, reserved for the accommodation of mail-vans and spare parcel-vans.

In some stations, by the side of the platform lines, small sorting sidings are laid down for spare carriages and vans. The lines of these sidings are connected with the platform lines by points, and the shunting operation is easy and rapid.

On the French railways, passenger trains generally have the parcel vans at both ends. In the case of the other administrations whom we have consulted, the vans are grouped in front and in the rear in certain cases where it is considered desirable to avoid shunting for detaching to vans.

QUESTION 14. — *Are empty trains brought up complete,* i. e. *with parcel and mail-vans, from the sorting groups to the platform lines, or are the already loaded vans brought separately to the ends of the trains; or does the train engine fetch them?*

Generally, the empty trains are brought up to the platform complete, and the loading of the luggage and mail-vans is done on the train, as we have just mentioned. Certain parcel and mail-vans, however, are coupled up at the platform, by means of electric tractors, after the empty train has been brought there; in other cases they may be added by means of the shunting engine or the train engine.

As regards this point, the arrangements for each train are laid down beforehand according to regulations devised to facilitate the train service as far as possible.

Question 15. — *Have you adopted any other special arrangements in making up trains with the object of reducing shunting to a minimum?*

In general it may be said that the make up of trains is everywhere arranged and carried out, as far as local conditions allow, with a view to reducing shunting as far as possible. With few exceptions, suburban trains do the return journey without any change in their composition; and long-distance trains, as far as possible, are not interfered with. Efforts are always made so that in dead-end stations there shall be no alteration in the make up of the trains.

Question 16. — *What arrangements have you adopted to secure the minimum of shunting in transferring through carriages from the trains of one line to those of another?*

The following is a summary of the information received : These trains are received on parallel roads, so as to expedite shunting, which, in dead-end stations, mostly takes place at the rear of the train.

Carriages are passed from one train to the other by an electric traverser, or by a shunting engine, or the train engine. With a view to this, through carriages are so placed that they can be immediately detached at the exchange station and put on to the new train, the station in question making preparation for the change at the appropriate spot. The change is effected either by a shunting engine or by rapid combined movements of the train engines of the train.

Questions 17 and 18. — *Is there a single central locomotive shed for the whole of the passenger station? Or have you provided special or auxiliary sheds for certain services? How are the locomotive sheds situated in relation to the main lines, the platform lines, and the sorting groups? What arrangements are adopted to reduce to a minimum the running of engines between the station and the shed? Are the lines which lead there independent?*

From the point of view of minimising the movements of engines, it is desirable to place the Sheds near to the station in proximity to the main lines leading to the platform lines, connecting the station with the shed by independent lines.

In the stations examined, the establishment of central locomotive sheds has generally been influenced by local conditions. The choice of site has been determined by the necessity of having it sufficiently large to hold the necessary lay-out. As a general rule a passenger station does not possess a locomotive shed specially for that station, but the same central shed serves several stations and all branches of the service. The shed is placed, where possible, near the principal station, and communication between the station and depot is almost always facilitated by independent lines which connect directly with the groups of platform lines and sorting sidings.

Lines to accommodate waiting locomotives, provided with water-cranes and turntables, are provided near the platform lines in certain stations served by a shed some distance away; or, there may be in the station a small auxiliary locomotive shed with coaling stages, used for special and shunting engines. In some stations special sheds for shunting en-

gines are placed between the most important groups of lines, and this arrangement appears very useful as it prevents the shunting engines being away for long intervals.

QUESTION 19. — *Do you use passenger motor-coaches or motor trains? Do you use trains which collect current from an electric conductor and can run in either direction?*

Electric-motor or steam-driven coaches, the latter little used, have the advantage of being able to run in either direction without it being necessary to reverse them. The same applies to electric motor vehicles. Electric traction also allows, especially for less heavy suburban traffic, fixing the composition of trains in a fixed formation with a motor vehicle at each end and so allows of running in both directions and avoiding shunting.

On the lines of the Paris-Orleans Company there are two systems of traction for the suburban trains running between Paris-Quai d'Orsay and Juvisy :

1° By double motor-coaches (one at each end) able to haul eleven carriages and to run in both directions;

2° By electric locomotives which involves changing ends at the terminus.

The Alsace and Lorraine Railway Company contemplates the resumption of the use of motor-coaches with accumulators.

Motor-coaches are in use on the electric route from Rotterdam to the Hague and to Scheveningen, on the Dutch State Railways. Trains of four carriages have a motor-coach at the head and one in the rear, so that they can run in either directions without change.

In Italy motor-coaches are used for light suburban trains, Trains composed of from two to four electric motor-coaches on the line from Milan to Varese are worked by means of the Thomson-Houston multiple control system. The trains run in either direction without change.

QUESTION 20. — *Have you adopted any special methods for the cleaning and heating of trains, and to what extent have they resulted in reducing the movement of the engine and shunting?*

From the replies received it appears that the cleaning of empty trains is done as a general rule while they are standing in the sorting sidings.

The cleaning does not affect the movement of engines or shunting.

Heating is effected either by the train locomotive or, underground pipes and steam valves. Empty trains are heated either at the platform or on the lines of the sorting sidings.

The special plants for preliminary heating have reduced the time of using locomotives before departure by about two-thirds.

QUESTION 21. — *In the terminal stations described, what is the experience obtained regarding shunting operations? What improvements have you effected since 1910, and what improvements do you propose to effect in the arrangement of lines with a view to reducing the movement of engines and empty rolling-stock?*

The replies of the administrations to this question are not sufficiently detailed to show the improvements made in the arrangement of lines with a view to solving the problem with which we are concerned; but it must be remembered that

in a large number of stations the effect of local conditions has rendered this problem secondary to more urgent considerations, and that since 1914 the war has prevented all progress in the solution of this question.

The Paris-Orleans Railway Company informs us of the construction of a subway at Paris-Austerlitz, making it possible to bring the empty carriages up to the making up sidings without crossing the main lines; the company also states that it wishes to extend electric traction.

The French Est Company has enlarged the sorting sidings at the Paris-Est station and improved its connection with the platform lines; and it contemplates the construction of accommodation near to Paris-Bastille with a view to reducing the movement of empty trains.

The Italian State Railways have had under consideration very important plans, some of which are already being carried out, for the re-arrangement of several large stations, as for example Rome, Naples and Bologna, and for the construction of new stations, as for example Milan-C.

The other administrations have carried out little work of any importance.

Question 22. — *Have you any passenger terminal stations with lines on more than one level? What is their general arrangement, and how are shunting operations carried on?*

The principal administrations consulted have replied that they have no passenger terminal stations with lines on more than one level. We may refer to the station at Naples which, on completion of work at present in progress, will have the platform lines for the « metropolitan » service, and for trains on the main Rome-Naples route, on a lower level than lines which serve the other routes ending at that station, but no special arrangements will be adopted as regards shunting.

Question 23. — *Have you any other special arrangements to report having as their object the reduction of movements of engines and empty rolling-stock?*

The administrations consulted have not notified any other special arrangements for reducing shunting operations.

CONCLUSION.

Before formulating the conclusions which may be drawn from the replies received and the observations made, it may be advisable to remark that, in the majority of passenger stations examined, it is not a question of new stations or new projects in which modern principles of layout have received their complete application, but of old stations rearranged whenever traffic has rendered this absolutely necessary.

These stations, indeed, had generally been constructed as dead-end stations in the interior of large towns, as near as possible to the centre, at a period when traffic did not approach its present-day volume.

When traffic began to show a considerable increase, somewhat extensive re-arrangements became necessary, but these had to be effected under very difficult conditions, due to lack of space and the high cost of purchasing additional land.

As regards these re-arrangements, the influence of local conditions has, in many

cases, compelled the administrations to resort to expedients which are not in harmony with the accepted general principles regarding modern lay-outs, and this has led to great diversity between different stations.

However, as we have already remarked, little progress has been made since the last Congress in 1910 in the matter of lay-outs designed to reduce shunting operations, the reason being that the War placed military requirements before everything else.

Moreover, it must not be forgotten that as regards the lay-outs, there may exist economic and local restrictions against which the considerations with which we are concerned may be ineffectual. On the other hand, in order to reduce the movements of engines and empty rolling stock, all administrations have laid down well-considered regulations designed to secure the utmost advantage from the lay-outs provided.

Having made these preliminary remarks, we now give the general principles which should, in our opinion, be observed in the design, and methods of using lay-outs in passenger terminal stations, in order to secure the greatest possible reduction of shunting empty rolling stock and engines, provided, of course, that local and special conditions permit.

A. — **As regards the lay-outs.**

1. — In stations which have very large suburban traffic it is desirable to concentrate this service on platform lines distinct from those used for the main line services which possesses different characteristics and requirements.

2. — Lines with pear shaped loops are the best means of simplifying and accelerating suburban traffic.

3. — The ordinary platform lines are the best fitted to reduce shunting to a minimum and to allow of the most complete utilisation of the lay-outs.

4. — Tracks at the end of the platforms, making possible the rapid changing of engines, are very useful. They may be used for the accommodation of vehicles to be either detached from or attached to trains at the platforms by means of traversers. The use of traversers will become more general.

5. — In order to release the engines of arriving trains from dead-end platform lines, when the rolling stock does not start out again immediately, or is not at once withdrawn, it may be desirable to connect twin platform lines, two by two, by a system of points, or by the interposition, if space allows, of a central running line; but the ideal solution, where possible, is that of having sufficient well-placed sorting sidings, as referred to below, while retaining the dead-end platform lines.

6. — The sorting sidings for empty trains must have sufficient lines to enable the platform lines to deal satisfactorily with all normal or maximum traffic, as regards either the number of trains, their composition, or the duration of their stay at the platform. The provision of adequate sorting sidings at passenger terminal stations cannot be too strongly recommended.

7. — The sorting sidings should be situated, as far as possible, in or quite near to the station, and should be so arranged that their lines are directly accessible for empty trains arriving from the platform lines, by simply running on or backing, without having to pull the train out. Each of the sorting sidings must serve the greatest possible number of platform lines, and it must be possible to clear several platform lines simultaneously

without interfering with the traffic on neighbouring lines.

When the sorting sidings are outside the station (it is not advisable for them to be too far away), an attempt should be made to connect them with the station by independent lines without making use of the main lines.

In this case, storage lines in the station for the temporary accommodation of empty trains are almost indispensable. In any case it is particularly useful to instal large cross-overs at the end of the station to give the greatest possible communication between the lines entering the station, the platform lines, and the sorting sidings. Small dead-end groups of lines placed by the sorting groups, and connected with them at one end by means of a draw-out track, are very convenient for making-up trains and for assembling the rolling stock.

8. — The placing of vans for the postal and parcels services on separate lines, so that the unloading and loading of parcels to be sent by passenger train may be carried out away from the platform lines, obviously necessitates a greater amount of shunting, but none the less, it has its advantages from the point of view of the general efficiency of the station.

Mechanical means for expediting the loading, unloading, and transfer of luggage, postal and ordinary parcels, appreciably reduce the time during which a train is at the platform, and cause less shunting.

9. — It is advisable to place the locomotive sheds as near to the station as possible, connecting the latter with this depot by independent lines; and to provide ready communication between the latter, the platform lines and the sorting sidings.

When the central locomotive shed is at a distance from the station, auxiliary accommodation inside the station for coaling, filling up with water, and reversing waiting engines may both facilitate and reduce the journeys of engines between the station and the depot, especially as regards shunting engines.

10. — It is desirable to use the sorting sidings for cleaning empty trains. The provision at the sidings of special installations for heating trains before departure to the platform lines makes a considerable saving of the time the locomotive has to be coupled to the train before its departure.

11. — Stations in which the spaces at the ends of platforms are not required for the convenience of passengers are the best for equipping with apparatus for liberating engines which arrive with trains at dead-end stations.

B. — As regards the methods of using the lay-outs.

1. — It is desirable that outgoing trains should retain the same formation as on arrival, especially in terminal stations. For trains entering and leaving such stations the arrangement recommended is to place a luggage van at front and rear.

2. — It is preferable to withdraw empty trains on arrival by means of the train engines, without using shunting engines.

3. — Finally, it is very advisable in the case of rapid suburban services, especially with electric traction, to use trains so formed as to be able to run in either direction without any alteration of the make up of the train.

[621 .132 1 (.42)]

British Locomotives in 1921.

DESIGNS AND WORK,

By J. F. GAIRNS,

MEMBER, INSTITUTION OF LOCOMOTIVE ENGINEERS.

Figs. 1 to 6, pp. 577 and 578.

Although arrears of repair and reconstruction from the war period are not, even yet, fully overtaken, the situation is now much more advantageous, and on several railways, in addition to steady progress in rebuilding older classes, and in adding to standard designs which still meet demands, new designs have been introduced during 1921. The most important, in that it includes features of novelty in regard to the railway concerned, is the three-cylinder 4-6-0 class, illustrated in figure 1, designed by Mr.W. Pickersgill, C. B. E., chief mechanical engineer, Caledonian Railway. Dimensions are given in the table appended under reference (*a*).

These engines are designed to deal with the very heavy trains found on certain West Coast services between Carlisle and Glasgow, and also between Glasgow and Perth. In both cases the gradients are severe, speeds fairly high, and loads frequently 400 tons or more, while in a number of instances several regular or conditional stops, sometimes at difficult places, add to the task of dealing with the heavier trains. This class is of special interest in that it is the first instance on a Scottish railway of the use of three high-pressure cylinders, as used on the English North Eastern and Great Northern Railways, and it is, besides, the heaviest 4-6-0 design on any railway in the British Isles.

With the moderate coupled wheel diameter of 6 ft. 1 in., and the necessarily very large boiler provided to supply three 18 1/2 by 26 inch cylinders, these engines are capable of remarkable work. In several respects the design is a departure from the older Caledonian standards. The outside cylinders drive the second coupled axle through 11 ft. connecting rods, the piston rods being lengthened. The inside cylinder actuates the leading coupled axle. Two sets of Walschaerts valve gear only are used, the piston valve for the inside cylinder being actuated through a simple arrangement of floating levers.

In 1917, Mr. J. G. Robinson, C. B. E., chief mechanical engineer, Great Central Railway (1) introduced a four-cylinder 4-6-0 design for heavy express traffic, following this with an improved class referred to but not illustrated in my

(1) See *Bulletin of the International Railway Association*, January-February-March, 1920, p. 11.

1920 article (1). It was then mentioned that a corresponding express goods class with 5 ft. 8 in. coupled wheels was under construction, and early in 1921 the first of these was placed in service. As illustrated in figure 2, the first engine of the class (*b*) is fitted for burning oil fuel, as it appeared at the time of the coal strike, which lasted from April 1 to nearly the end of June 1921. Others of the class were completed as coal burners, and No. 72 has since had the special fittings removed. In general features the design corresponds closely with the « Valour » class described last year, except for its smaller coupled wheels and consequent alterations. It has the new type of cab now used for both 4-4-0 and 4-6-0 engines.

In 1920, Mr. G. J. Churchward, C.B.E., who retired at the end of 1921, after having been chief mechanical engineer of the Great Western Railway since 1902, designed the first 2-8-0 locomotive for « mixed-traffic » purposes in British practice (2). This engine has been subjected to extensive trial, and has proved capable of fast work, notwithstanding its eight coupled wheels of 5 ft. 8 in. diameter, and of taking heavy loads with great efficiency. As built, however, it had a standard boiler, instead of that intended for it. During 1921, the proper boiler was placed upon it, and in this form, which makes it the heaviest 10-wheeled locomotive in British practice, it is illustrated in figure 3 (*c*). Further engines of this class, but built new with the large boiler, are under construction.

In 1910, Mr. G. Hughes, C.B.E., chief mechanical engineer, Lancashire & Yorkshire Railway, introduced a class of four-cylinder 4-6-0 locomotives with 6 ft. coupled wheels, designed for mixed-traffic duties, but often used for heavy express train working. Towards the end of 1920 some of these engines appeared in rebuilt form, fitted with superheating apparatus, new cabs and various improvements, and one of them is illustrated in figure 4 (*d*). The remainder have since been rebuilt in the same manner, and during 1921 a further series were built to the same design. A feature of traffic working on the Lancashire & Yorkshire Railway is the frequency with which junction slacks and speed orders occur, and in combination with the very severe gradients on many routes and the heavy loads, there is need for engines of great power, especially as it is often necessary for them to take also express goods and other trains unsuitable for the more ordinary types of passenger engines. The new class thus constituted has been used also for certain express train duties hitherto performed by London & North Western Railway engines, in view of the amalgation of the two companies completed at the end of 1921, but which had been preceded by associated working in many respects.

Another notable design, though it is not illustrated, is that of Mr. W. M. Morton's 0-6-0 mixed-traffic class (*e*), with 5 ft. 8 in. coupled wheels, for the Midland Great Western Railway of Ireland.

These locomotives have been designed for working fast live-stock specials and other express goods trains, the proportions and weights being limited to suit all branches of the system. Steam heating is fitted, so that the engines may be used for heavy excursion traffic when required. It is of interest to note that

(1) See *Bulletin of the International Railway Association*, April 1921, p. 7.

(2) See *Bulletin of the International Railway Association*, January-February-March, 1920, p. 13.

Fig. 1. — Three-cylinder 4-6-0 express locomotive Caledonian Railway.

Mr. W. Pickersgill, C. B. E., chief mechanical engineer.

Fig. 2. — Four-cylinder 4-6-0 express goods oil-burning locomotive, Great Central Railway.

Mr. J. G. Robinson, C. B. E., chief mechanical engineer.

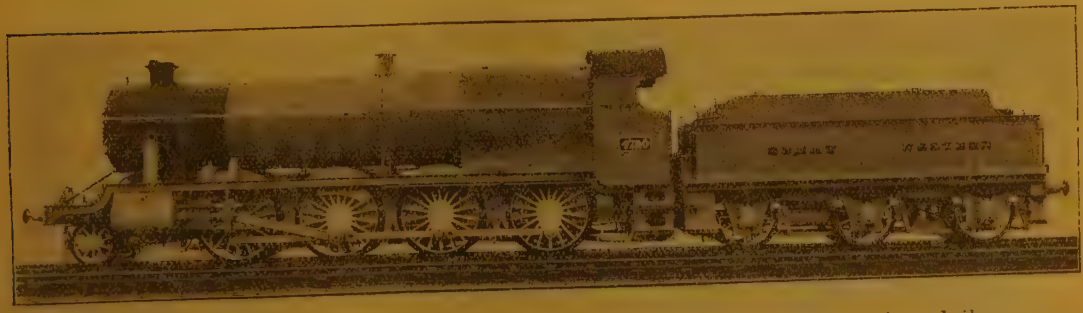


Fig. 3. — 2-8-0 mixed-traffic locomotive, Great Western Railway, as fitted with large boiler.

Mr. G. J. Churchward, C. B. E., chief mechanical engineer.

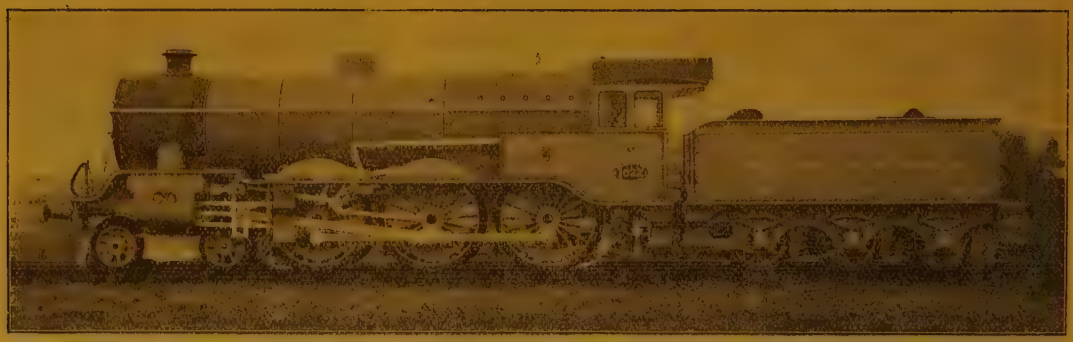


Fig. 4. — Rebuilt four-cylinder 4-6-0 locomotive, Lancashire & Yorkshire (New London & North Western) Railway

Mr. G. Hughes, C. B. E., chief mechanical engineer.

Fig. 5. — 4-8-0 shunting tank engine, London & South Western Railway.

Mr. R. W. Urie, chief mechanical engineer.

Fig. 6. — 4-6-4 tank engine, Furness Railway.

Mr. H. D. L. Rutherford, locomotive, carriage & wagon superintendent.

these engines are the first introduced in Ireland expressly for mixed-traffic working.

On the Great Northern Railway, Mr. H. N. Gresley built a three-cylinder 2-8-0 engine (*f*), representing an improvement on the original class described in the 1914-1919 article (1). In the new engine the outside cylinders are almost horizontal, the three steam-chests being in line above the outside cylinders and at one side of the inside cylinder. Cylinder diameter is increased, steam pressure is raised and heating surface is modified.

Th se complete the new tender engine designs of note introduced during 1921. Of the 1920 classes, further engines have been built of Mr. H. N. Gresley's 2-6-0 three-cylinder locomotives for the Great Northern Railway, Mr. R. W. Urie's four-cylinder 4-6-0 express goods engines for the London & South Western Railway, and of Sir Vincent Raven's three-cylinder 4-6-0 express goods engines for the North Eastern Railway, described a year ago. Further 4-4-0 engines have been rebuilt on the South Eastern & Chatham Railway to Mr. R. E. L. Maunsell's superheater design, while on the Glasgow & South Western Railway many more 4-4-0 locomotives have been rebuilt by Mr. R. H. Whitelegg. Of engines considered in the 1914-1919 article, further 2-8-0 's of the three-cylinder and two-cylinder classes have been added by Mr. Gresley on the Great Northern Railway; additional 4-6-0 four-cylinder locomotives have been added on the Great Southern & Western Railway of Ireland by Mr. E. A. Watson; four more superheater 4-6-0 's of Mr. Cumming's design were placed in service on the Highland Railway; and Mr. R. E. L. Maunsell, C. B. E., has added further 2-6-0 mixed-traffic engines on the South Eastern & Chatham Railway. Other additions are to the four-cylinder 4-6-0 « Claughton » class on the London & North Western Railway; to Mr. Gresley's ordinary 2-6-0 two-cylinder class on the Great Northern Railway; the « 1500 « class 4-6-0 's on the Great Eastern Railway, built by Messrs. Beardmore & Company to Mr. A. J. Hill's designs, have been completed; Mr. G. J. Churchward has added to the useful 2-6-0 mixed-traffic class with 5 ft. 8 in. wheels on the Great Western Railway; lieutenant-colonel L. Billinton has built further 2-6-0 's, with a special top-feed dome, for mixed-traffic work on the London, Brighton & South Coast Railway; two new superheater 4-4-2 's were added by Mr. W. Chalmers to the locomotive stock of the North British Railway; and new 4-4-0 's were placed in service on the Great North of Scotland Railway. On other railways existing ordinary classes have been built, and many older engines have been rebuilt and in most cases superheated, if not already so fitted.

Of the tank engines three designs of special note require mention. Two of these are due to Mr. R. W. Urie, chief mechanical engineer, London & South Western Railway. They are in general similar, except that one is 4-8-0 and the other 4-6-2, and therefore only one is illustrated, the former, in figure 5. Both owe their origin to the construction of a large concentration yard at Feltham, a few miles out of London. Here the « hump » principle is adopted for distributing wagons, and the 4-8-0 (*g*) engines are employed for this work, which demands great power and high acceleration capabilities. The 4-6-2 engines (*h*) are intended for working local goods trains

(1) See *Bulletin of the International Railway Association*, January-February-March, 1920, p. 11.

to and from the concentration yard, and particularly between it and the large London goods depots. Cylinders and motion of the 4-6-2 type tank engines are interchangeable with those of the 4-6-0 goods locomotives introduced a year ago, whilst the same parts in the new 4-8-0 type tank engines are similarly interchangeable with those of the 4-6-0 express locomotives. The bogies used with these engines are of the same design as those employed in the express goods locomotives referred to.

The other design illustrated (fig. 6) is a remarkable 4-6-4 tank engine class (*i*), designed by Mr. D. L. Rutherford for the Furness Railway. Intended for working heavy traffic on the main routes, these locomotives, constructed by Kitson & Company, of Leeds, are remarkable in that they are the first engines of this type to be built with inside cylinders, while they are not equipped with superheating apparatus.

In regard to other developments, lieutenant-colonel L. Billinton has added further 4-6-4 express tank engines on the London Brigton & South Coast Railway, of the 327 class illustrated in the 1914-1919 article. These include several improvements, notably in the arrangement for top-feed. Among other tank engine developments of 1921, principal interest attaches to the series of 0-6-2 locomotives (*j*) added by Mr. H. N. Gresley on the Great Northern Railway. These constitute a development of an older class introduced by Mr. Ivatt, but are now equipped with superheating apparatus; a boiler feed pump is fitted in view of tunnel working in the London district, the engines being adapted for condensing, and the boiler centre line is higher than hitherto.

The other design is an improved version of Mr. A. J. Hill's 0-6-2 tank engine (*k*) for the Great Eastern Railway. Originally, two trial engines were built, one with superheating apparatus and the other without. Those now added are of the latter class, but include top-feed and several detail improvements. They have been employed on a wide range of duties, including trains travelling some distance down the main lines, and, despite their small wheels, are capable of good speeds, while their hauling powers are considerable.

During the coal strike period (April-June) British railways were very severely handicapped, and on several lines considerable numbers of engines were adapted for burning oil as fuel. On the Great Eastern Railway 75 were thus converted, using the Holden system, which originated on that line, though for many years past only a few oil-burning engines have been in use. On this line, as also on the Great Central Railway, where the « Unolco » system was used, it became, in fact, practicable to increase train facilities because of the use of oil, after very heavy reductions had necessarily been made. The London & North Western, Great Northern, London & South Western, Highland, North British, and one or two other lines used the « Scarab » system. On the Midland and North Staffordshire Railways a system introduced by Sir Henry Fowler was employed. But only the Great Eastern, Midland, and Great Central Railways fitted engines in considerable numbers, the others having a few engines so fitted, and though oil thus assisted materially to overcome the difficulties of the strike period, most of the engines thus adapted are again burning coal, and, while the period of fuel shortage lasted, wood, coke and foreign coal were mainly employed.

At this time very notable hauling feats were performed owing to the policy on several lines of combining trains so as to economise engine power. Speeds were reduced, and on the Great Northern Railway Mr. Gresley's 2-6-0 locomotives (2 and 3 cylinder classes) were often used for expresses of from 500 to 650 tons, representing as many as 20 modern bogie coaches of the largest types.

II. — Work.

As space is severely limited on this occasion, it is proposed to confine this section to a few remarks on train schedules in 1921, omitting reference to actual performances. In February, 1921, the London, Brighton & South Coast Railway restored practically its pre-war schedules, including 60-minute trains between London and Brighton (51 miles) and 90-minute trains on the Eastbourne route (66 miles). The South Eastern & Chatham Railway had virtually attained pre-war standards in 1920, and the summer arrangements for 1921, continued through the winter, gave further expresses with such times as 85 minutes for the 70 miles between Charing Cross and Folkestone Central, and 92 minutes for the 74 miles from Victoria to Margate West, both including heavily graded sections and worked by relatively small 4-4-0 engines.

On other railways the summer timetables involved improvements and accelerations, but the climax was reached when, on 3 October, the Great Western Railway restored its pre-war times, including trains scheduled in two hours between London and Birmingham, 110 miles (the London & North Western also did the same for 113 miles); London and Bristol, 117 1/2 or 118 1/2 miles according to route in 120 minutes; London and Plymouth, 226 3/4 miles in 247 minutes; London and Exeter, 174 miles in 180 minutes; together with many other notable times. On other lines pre-war standards were not achieved, chiefly because of the inclusion of stops for service and other reasons so that although the actual requirements are almost those of 1913 and 1914 and the loads are heavier, they do not appear quite so meritorious as they really are. Several railways have added considerably to their facilities, in some instances adopting regular times, such as 0, 20, 30 or 50 minutes past each hour, for main line service. Important through carriage facilities have also been added, as from Aberdeen to Penzance, Aberdeen to Plymouth, Edinburgh to Southampton, and most of the cross-country expresses of pre-war days have been restored.

LEADING DIMENSIONS OF LOCOMOTIVES ILLUSTRATED AND DESCRIBED.

T = Tank engine. — R = Rebuilt.

Reference.	Figure.	RAILWAY.	Type.	Cylinders. Diameter and stroke (inches).	Diameter of coupled wheels.	Heating surface (square feet).			Grate area (square feet).	Steam pressure (lb. per square inch).	Weight (engine only) in working order (tons).
						Tubes.	Fire-box.	Super-heater.			
(*a*)	1	Caledonian	4-6-0	18 1/2 × 26 (3)	6′ 1″	2 200	170	270	28	180	81
(*b*)	2	Great Central	4-6-0	16 × 26 (4)	5′ 8″	1 881	163	343	26	180	79 1/2
(*c*)	3	Great Western	2-8-0	19 × 30	5′ 8″	2 062.35	169.75	323.9	30.28	225	82
(*d*)	4	Lancashire & Yorkshire . .	4-6-0 R	16 1/2 × 26 (4)	6′ 3″	1 511	175	552	27	180	79
(*e*)	...	Midland Great Western . .	0-6-0	19 × 26	5′ 8″	821	126	210	17.3	175	48
(*f*)	...	Great Northern.	2-8-0	18 1/2 × 26 (3)	4′ 8″	1 868.5	163.5	430.5	27.5	180	75 3/4
(*g*)	5	London & South Western .	4-8-0 T	22 × 28	5′ 1″	1 267	139	231	27	180	97
(*h*)	...	— — — .	4-6-2 T	21 × 26	5′ 7″	1 267	139	231	27	180	96 1/2
(*i*)	6	Furness	4-6-4 T	19 1/2 × 26	5′ 8″	1 850	153	...	26	170	92 3/4
(*j*)	...	Great Northern.	0-6-2 T	19 × 26	5′ 8″	880	118	207	19	170	70 1/4
(*k*)	...	Great Eastern	0-6-2 T	18 × 24	4′ 10″	1 281.2	113	...	17.7	180	60 3/4

[625 .143.2]

Basic Bessemer steel rails,

By Cecil J. ALLEN,
A. M. INST. T.

Fig. 1, p. 587.

(*The Railway Engineer.*)

In the issues of the *Railway Engineer* for June, 1920, and May 1921 (1), articles were published dealing respectively with rails made by the open-hearth basic and Bessemer acid processes, and giving the results of certain recent experiments with both processes in the direction of producing harder and more durable rail steel. In the present article the writer desires to supplement the foregoing information with details of the modern methods employed on the Continent of Europe in the production of rails by the basic Bessemer process. The notes on which the article is based were made in course of the inspection of a contract for bull-head rails of the 95 lb. British Standard section at a rolling mill in the Duchy of Luxembourg, and the analyses and tests about to be set out are characteristic of the ordinary course of basic Bessemer steel manufacture, rather than of any special experiments directed toward the production of very hard steel. In order that a close comparison may be made between this class of steel and that manufactured by the Bessemer acid and openhearth basic processes under equally normal conditions, the writer has averaged in the annexed table the results of analyses and tests carried out during the course of five different contracts, in each case for 1 000 to 2 500 tons of rails — to medium carbon Bessemer acid and open-hearth basic specifications, to high carbon specifications by the same processes, and to the medium carbon basic Bessemer specification just referred to. These comparisons afford a considerable amount of information as to the relative merits of the three chief methods of steel production employed in the manufacture of rails. Incidentally, they throw some doubt on the contention, frequently expressed, that it is impossible to make a basic Bessemer steel that shall be as reliable in its analysis and properties as steel of acid Bessemer or acid or basic open-hearth quality.

To explain the origin of this contention it is necessary first of all to run very briefly over the fundamental differences between these steel processes. Chronologically, the Bessemer acid process was the first, wherein the molten unrefined iron is held in a convertor and refined of its carbon and silicon by combustion (air being blown from the base of the convertor through the molten mass for this purpose), prior to the addition of known amounts of spiegel, ferro-manganese and ferro-silicon in order to furnish the percentages of carbon, manganese and silicon required in the final analysis of the steel. By this method, however, the phosphorus and sulphur in the iron are not refined out, and it is

(1) See *Bulletin of the International Railway Association* September 1921, p. 1334.

therefore impossible to employ the Bessemer acid process in order to convert to steel iron smelted from low-grade phosphoric ores, which form by far the major part of the world's ore deposits. But the experiments of Thomas and Gilchrist proved that, if the convertor be lined with dolomite, or magnesian limestone, composed of approximately equal parts of lime and magnesia (both of which are strong bases in chemistry) oxidisation of the phosphorus and sulphur can take place. This discovery gave a considerable impetus to steel manufacture, which had up till that time been practically dependent on the limited deposits of hematite ore as its source of iron supply, and extensive Bessemer basic plants grew up round all the principal phosphoric ore-fields. Subsequently Siemens and Martin evolved their open-hearth furnace, wherein the molten iron is held for purposes of refinement in an open hearth or bath, over the surface of which producer gas is passed in order to effect the same change in the condition of the iron as that which takes place in the convertor. By lining the hearth with dolomite the open-hearth process becomes available for the conversion of phosphoric pig-iron, and the two grades of open-hearth steel are thus distinguished — acid open-hearth from an ordinary furnace, lined only with ganister, and basic open-hearth, from the dolomite-lined furnace.

Conversion by the Bessemer process.

The Bessemer convertor is a vessel holding generally from 12 to 30 tons of molten metal, whereas the open-hearth furnace has a capacity of 40 to 50 tons or more. But the time of conversion by the former is some 20 minutes, against from six to eight hours by the latter. Thus, whereas a plant of three 15-ton convertors, two in constant use, turn and turn about, and the other idle for relining, is capable of producing some 1 080 tons of steel per day, a plant of three open-hearth furnaces, two in use concurrently and the third idle, could only produce at most 400 tons, even assuming the minimum period of six hours as the time of conversion. Consequently, the Bessemer process is materially the more economical of the two to operate. Taking into account the fact that hematite pig-iron, derived from the rarer ore, is of greater value than the ordinary or phosphoric pig, the ultimate result is to place Bessemer acid and open-hearth basic steel roughly on a par as regards the cost of production, open-hearth acid being the most expensive process and rarely, if ever, used in rail production, while Bessemer basic, combining the economy in time of the Bessemer process with the cheapness of phosphoric iron, is the cheapest. The last-mentioned is the process used almost exclusively for the production of rails in France, Belgium, Luxembourg and Germany, where ores are abundant and peculiarly suitable, when reduced to iron, for conversion by this process.

In operation the Bessemer process suffers from the disadvantage that, during the conversion from iron to steel, the condition of the metal within the convertor can only be judged by the size and colour of the flames issuing from its mouth, as compared with the complete control available over the open-hearth process at all stages of conversion. In the case of the Bessemer acid process this disadvantage is to a large degree nullified by the fact that the percentage of phosphorus and sulphur in the finished product will be regulated absolutely by the percentage of both elements present in the original iron. But in the Bessemer basic process the steelmaker is under the necessity of judging the extent of phosphorus reduction by the visual method just mentioned, and it is to this cause that the process in question owes its reputation of uncertainty of result, as compared with the comparative

certainty of open-hearth or acid Bessemer working. There can be no doubt that that reputation has been to a large degree fostered in the past by the careless way in which much basic Bessemer rail steel has been manufactured, especially in the United States, leading to a high percentage of rail fractures owing to unduly high phosphorus content. In this country, where factors of safety are high, basic Bessemer rail steel has been looked upon by railway engineers with such disfavour, owing to its uncertain properties, that only one or two lines of recent years have continued to admit it in their specifications; consequently, with one or two exceptions, all the Bessemer basic steel plants here have now been replaced by open-hearth basic methods. As previously explained, however, on the Continent of Europe the Bessemer basic or, as it is generally known, « Thomas » process, operates almost exclusively in the manufacture of rail steel. The systematic methods by which a reasonable certainty of result is attained may now be described.

Reactions in the basic convertor.

At the steelworks at which the writer was engaged, the lining of the convertors is effected with large blocks, composed of finely-ground dolomite — whose formula is CaOMgO in its natural condition, but becomes $CaMg(Co^3)^2$ after calcining — mixed with 10 to 15 % of liquid tar, and then compressed in moulds at a pressure of 300 kgr. per cm^2. When once lined, each convertor is good for about 220 charges or « blows »; the base, containing the *tuyères* or perforations through which the air-blast is passed, is prepared in a special ramming machine, and will withstand about 60 successive charges. To the charge of molten iron, which at this works amounts to 12 tons per convertor, an average of 13 % of lime (CaO) is added for help in refining out the phosphorus. After the charge has been poured in the air-blast is commenced, and the convertor is rotated to the vertical. The first reaction to take place is the burning out of the silicon, according to the formula :

$$Si + O^2 = SiO^2$$
$$SiO^2 + nCaO = (CaO)^nSiO^2.$$

This reaction lasts about three minutes and is marked by a bluish flame at the mouth of the convertor. Towards the end of the period the flame gradually changes to bright yellow, and the ebullition in the convertor becomes very violent as the refinement of the carbon commences. In this case the formula is :

$C+O=CO$, or, alternatively, $C+O^2=CO^2$

according to the temperature at which the reaction takes place. In the acid process this reaction, which lasts from 10 to 13 m., would represent the completion of the « blow », but the essential feature of the basic process is that the blow is now continued for the purpose of refining out the phosphorus in what is known as the « after-blow ». The commencement of the after-blow is clearly marked by a shortening of the flame at the mouth of the convertor, and its conclusion, after 1 1/2 to 2 1/2 m., is denoted with equal clearness by the emission of brown fumes from the convertor, which indicate that, the phosphorus having been practically removed, the iron itself is now commencing to burn. The reaction by which the phosphorus is removed is as follows :

$$P^2+O^5=P^2O^5.$$
$$P^2O^5+4\ CaO=4CaO.\ P^2O^5.$$

The effect of this reaction is to reduce the phosphorus content from an average of 0.65 to 0.70 % in the original ore to one of less than 0.05 % at the steelworks in question. The convertor is then rotated to the horizontal and the slag poured off the surface of the iron, at which stage a small sample of the metal is taken, cooled in wa-

ter, hammered out and fractured. A rough crystalline fracture (as compared with a smooth grey fracture) indicates any excess of phosphorus remaining in the charge, but the flame indications are so clearly marked that the latter should not frequently happen. The contents of the convertor approved, the final operation is to make the additions which will give to the finished steel the exact percentages of carbon, silicon and manganese required. For the manganese and carbon contents the appropriate quantity of solid ferro-manganese is added to the molten metal in the convertor, and molten spiegel is poured into the casting ladle prior to the emptying of the contents of the convertor into it, and the small percentage of silicon required is the final addition, in the form of solid ferro-silicon in bags, to the ladle before casting the metal in the ingot-moulds.

Graphic method of estimating additions after refinement.

The certainty or uncertainty of basic Bessemer steel working is governed principally by the care bestowed on the duration of the blow and after-blow in the convertor, and by the system or lack of system obtaining in regard to the final additions to the bath of metal to determine its analysis. As in the case of so many comparable processes, systematic working is the only secret of success. At the works at which the writer was engaged in inspection these additions are made by the help of an ingenious graphic method designed by M. Adolphe Fischer, engineer at the Rodange (Luxembourg) steelworks of the Belgian Ougrée-Marihaye Company, by whose kind permission the diagram referred to is reproduced herewith. The diagram is based on an initial charge in the convertor of 1 000 kgr. (= one metric ton). It presupposes that the spiegel always contains the same percentage of carbon, valued at 4.5 %, and that the yield of carbon in the anthracite employed is 50 %. It also takes count of the fact that, after blowing, the molten metal contains from 0.05 to 0.06 % of carbon. In using the graphs the steelmaker starts from the hypothesis that the loss of manganese occasioned by deoxidisation is equal to the amount found in the bath of metal after the blow is complete; further, that during the process of melting, the spiegel used loses from 10 to 15 % of its manganese.

The method of using the graphs is best illustrated by making a hypothetical cast of steel to answer, say, to an analysis of 0.45 % carbon, 0.90 % manganese, and 0.100 % silicon, corresponding to the class of steel rolled into the rails, whose analysis and tests figure in the table given in the present article. For the additions there are assumed to be available cast spiegel containing 4.5 % carbon, 0.5 % silicon, and 11 % manganese; ferro-manganese containing 7 % carbon and 80 % manganese; ferro-silicon containing 50 % silicon, and anthracite containing 50 % carbon. After blowing it is assumed that the bath of metal contains 0.05 % carbon, 0.06 % phosphorus, and no silicon or manganese.

In regard to manganese, if we add 2.5 kgr. of ferro-manganese (containing 80 % manganese) in the convertor, reference to Scales A and D shows that the bath gains 0.20 % manganese. To obtain the requisite analysis of 0.90 %, therefore, the balance of 0.70 % must be obtained from spiegel. Reference to Scales D and B shows that the amount of spieged (11 % manganese) required to produce 0.70 % of manganese in the steel is 64 kgr. As regards carbon, assuming that the blown bath contains 0.05 %, Scales A and E show that the 2.5 kgr. of ferro-manganese (containing 7 % carbon) already added produce an increase of 0.01 in the carbon content and Scales B and E show that the 64 kgr. of spiegel (4.5 % carbon) added

occasion a further addition of 0.29 % carbon. The amounts of 0.05, 0.01 and 0.29 added together make a total of 0.35 %, and to reach the specified figure of 0.45 % carbon it is, therefore, necessary also to add anthracite. The amount required for an addition of 0.10 % carbon (Scales A and D, or, better, F and E,

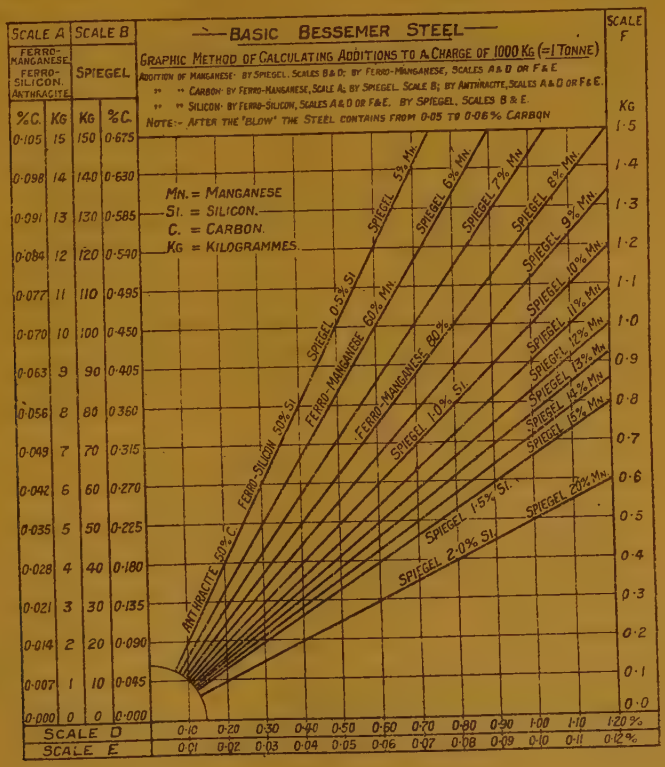

BASIC BESSEMER STEEL
GRAPHIC METHOD OF CALCULATING ADDITIONS TO A CHARGE OF 1000 KG (=1 TONNE)
ADDITION OF MANGANESE BY SPIEGEL. SCALES B & D; BY FERRO-MANGANESE, SCALES A & D OR F & E.
" " CARBON BY FERRO-MANGANESE, SCALE A; BY SPIEGEL. SCALE B; BY ANTHRACITE, SCALES A & D OR F & E.
" " SILICON BY FERRO-SILICON, SCALES A & D OR F & E. BY SPIEGEL. SCALES B & E.
NOTE:- AFTER THE 'BLOW' THE STEEL CONTAINS FROM 0·05 TO 0·06% CARBON
MN. = MANGANESE
SI. = SILICON.
C. = CARBON.
KG = KILOGRAMMES.
SCALE A
FERRO-MANGANESE. FERRO-SILICON. ANTHRACITE.
%C. KG
SCALE B
SPIEGEL
KG %C.
SCALE F
KG
SCALE D
SCALE E
SPIEGEL 5% MN.
SPIEGEL 6% MN.
SPIEGEL 7% MN.
SPIEGEL 8% MN.
SPIEGEL 9% MN.
SPIEGEL 10% MN.
SPIEGEL 11% MN.
SPIEGEL 12% MN.
SPIEGEL 13% MN.
SPIEGEL 14% MN.
SPIEGEL 15% MN.
SPIEGEL 20% MN.
SPIEGEL 0·5% SI.
SPIEGEL 1·0% SI.
SPIEGEL 1·5% SI.
SPIEGEL 2·0% SI.
FERRO-MANGANESE 60% MN.
FERRO-MANGANESE 80%
FERRO-SILICON 50% SI.
ANTHRACITE 50% C.

Fig. 1. — Graphic method of calculating additions.

which give the same results magnified ten times) is found to be 2 kgr. As regards silicon, the addition of 64 kgr., of spiegel (0.5 % silicon) already made provide 0.032 % silicon in the bath (Scales B and E), and the difference between 0.032 and 0.100 (= 0.068) therefore requires to be made up. Using the magnified Scales E and F (in place of Scales A and D), we find that the addition of ferro-silicon (50 % silicon) necessary is one of 1.36 kgr. As previously mentioned, these weights are all based on an initial charge of one metric tonne; in respect of a charge of 20 tonnes, therefore, the additions necessary to arrive at the specified analysis would be the same figures multiplied by 20, *i. e.*, 50 kgr. of ferro-manganese (80 % manganese), 1 280 kgr. spiegel (11 % manganese), 40 kgr. anthracite, and a shade over 27 kgr. ferro-silicon (50 % silicon). The analyses of the finished steel from the first few charges serve to show if the theoretical additions are achieving the desired results, or if slight adjustments

are required in the quantities. In this way is attained a certainty of result exceptional for the basic Bessemer process.

Comparison of analysis and test results.

This certainty is best appreciated by a study of the figures of the table hereafter in regard to the Bessemer basic, Bessemer acid, and open-hearth basic processes respectively. They represent the composition and properties under test of steel rails made in fairly large quantities to five different specifications. There is first a rolling of 1 500 tons under the medium carbon (0.40 to 0.50 %) basic Bessemer specification on which this article is based. Then follow rollings, of comparable hardness, to the old British Standard Specification (0.35 to 0.50 % carbon) — 1 500 tons by the Bessemer acid process and 2 000 tons by the open-hearth basic process; and, lastly, rollings to the revised but not yet published British Standard High Carbon Specification — 1 000 tons by the Bessemer acid process (0.45 to 0.55 % carbon) and 1 500 tons by the open-hearth basic process (0.55 to 0.65 % carbon). It was not deemed advisable to allow the basic Bessemer steel makers to advance to a higher percentage of carbon than 0.50 until some experience had been obtained with the rails in service; indeed, the writer found the firm concerned distinctly disinclined to proceed higher in carbon than at most 0.55 %, in view of possible breakages at the falling weight test. All the rails rolled in each contract were of the 95 lb. British Standard bull-head section.

The table is divided into three principal parts, the first giving the results of analysis; the second the deflections under the successive blows of a weight of 1 ton on 5-foot lengths of rail (supported at 3 ft. 6 in. centres) from heights of 7 feet and 20 feet, and the third the ultimate strength of the steel and percentages of extension and contraction under the tensile test. In each contract a falling weight test was made in respect of every cast of steel rolled into rails and a tensile test once in every 100 tons. In the basic Bessemer contract an analysis was supplied in respect of every cast, whereas in the other medium carbon contracts one complete analysis was only made in respect of each 200 tons rolled, and in the high-carbon contracts one in each 100 tons. Independent analyses were also made at intervals, to check the accuracy of the works analyses, and show a good measure of agreement, especially in the case of the basic Bessemer steel. It will be seen that the figures relating to each item are subdivided into three parts — first the specified limits, then the highest and lowest figures actually recorded, and last the mean of all the figures recorded under each heading.

Reliability of basic Bessemer steel.

Some support may appear to be lent to the contention that basic Bessemer working is more uncertain than that of either of the other two processes in that, almost without exception, the maximum and minimum actual results given in the first column show the widest variation of any, whether in the matter of analysis or tests. As regards analysis, however, excess of actual over specified limits only occurred in the case of carbon, in a total of 5 out of 150 casts (save for a minute excess of 0.01 % manganese in one cast), whereas variation in other elements, even if greater than the corresponding Bessemer acid or open-hearth variations, was always within the specified limits, and therefore in no way exceptionable. Basic Bessemer tests were also in all cases within limits, save that 3 casts out of 150 showed a slight excess over the maximum deflection allowed under the falling weight. It should be added that, in contradistinction to the rollings of Bessemer acid and open-hearth basic rails, which, were in

Results of rail tests, Bessemer basic, Bessemer acid and open-hearth basic process respectively.

Class of steel. . .	Medium carbon.			High carbon.	
Process.	Bessemer basic.	Bessemer acid.	Open-hearth basic.	Bessemer acid.	Open-hearth basic.
Number of casts.	150	140	48	80	30
Approximative weight of finished rails	1 500 t.	1 500 t.	2 000 t.	1 000 t.	1 500 t.
Chemical analysis.	%	%	%	%	%
Carbon :					
Specified	0.40-0.50	0.35-0.50	0.35-0.50	0.45-0.55	0.55-0.65
Actual	0.40-0.54	0.46-0.50	0.39-0.49	0.47-0.53	0.55 0.63
Mean.	0.463	0.480	0.448	0.504	0.583
Manganese :					
Specified	0.70-1.00	0.70-1.00	0.70-1.00	0.90 max.	0.80 max.
Actual	0.70-1.01	0.75 0.95	0.71-0.87	0.73-0.84	0.74-0.89
Mean.	0.947	0.897	0.809	0.793	0.781
Silicon :					
Specified	0.150 max.	0.100 max.	0.100 max.	0.100-0.300	0.100-0.300
Actual	0.084-0.130	0.053-0.084	0.037-0.051	0.103-0.131	0.110-0.210
Mean.	0.097	0.069	0.044	0.116	0.152
Sulphur :					
Specified	0.070 max.	0.080 max.	0.080 max.	0.060 max.	0.050 max.
Actual	0.022-0.045	0.041-0.057	0.036-0.059	0.033-0.049	0.034-0.047
Mean.	0.035	0.051	0.047	0.041	0.042
Phosphorus :					
Specified	0.070 max.	0.075 max.	0.075 max.	0.060 max.	0.040 max.
Actual	0.027-0.054	0.051-0.055	0.016-0.038	0.056 0.060	0.022-0.045
Mean.	0.043	0.053	0.031	0.058	0.035
Deflections under falling weight test.	Inches.	Inches.	Inches.	Inches.	Inches.
First blow at 7 feet :		0.88-1.19	0.88-1.19	...	...
Specified	...	0.88-1.13	1.00-1.13	0.69-0.94	0.78-1.06
Actual	0.91-1.22	0.948	1.046	0.790	0.925
Mean.	1.024				
Second blow at 20 feet :					
Specified	4.10 max.	3.00-4.25	3.00-4.25	4.10 max.	4.10 max.
Actual	3.23-4.25	3.19-3.88	3.50-4.13	2.81-3.38	2.81-3.75
Mean.	3.652	3.452	3.701	3.023	3.280
Tensile test results.	Tons per square inch.	Tons per square inch.	Tons per square inch.	Tons per square inch.	Tons per square inch.
Ultimate stress :					
Specified	42.0 min.	40.0-48.0	40.0-48.0	44.0 min.	46.0 min.
Actual	42.0-49.9	41.8-48.2	42.0-48.4	46.4-52.0	47.2-57.0
Mean.	45.41	45.87	46.10	49.54	52.16
Extension in 3 inches :	%	%	%	%	%
Specified	(1) 12.0 min.	15.0 min.	15.0 min.	(1) 12.0 min.	(1) 12.0 min.
Actual	15.7-27.0	14.7-20.3	15.0-22.0	14.0-20.5	10.0-16.0
Mean.	20.70	17.00	18.48	16.80	12.50
Contraction :					
Actual	17.3-42.5	15.1-26.3	18.6 45.3	21.0-33.8	11.6-25.2
Mean.	30.50	20.37	32.80	24.98	18.89

(1) 10 %. minimum allowed if ultimate stress 50 t. per square inch or over.

each case completed at one operation, the Bessemer basic rolling was carried out in three stages, and included the largest number of casts of any, which facts in themselves are likely to produce the greatest variation in results. Consideration of these analysis and test results, therefore, cannot be held to prove uncertainty in the character and properties of steel made by the Bessemer basic process, when systematic methods of the nature described are employed in its manufacture.

Comparing the analysis results of the five rollings, we see that phosphorus shows the lowest average in the case of the open-hearth basic process, as is to be expected, one contract, in which a percentage as high as 0.075 was allowed, showing a maximum figure of only 0.038 %. Similarly, in the case of the Bessemer basic process, in which a maximum of 0.070 % phosphorus was allowed, an actual maximum of 0.050 % was worked to, save in the case of one cast only, which reached 0.054 %. This clearly proves the possibility of obtaining consistently low phosphorus percentages by the basic Bessemer process. The Bessemer acid phosphorus percentages are the highest, although always within specified limits. As previously mentioned, the phosphorus percentage of the original iron remains unchanged in this process, which accounts for the remarkable uniformity of the actual phosphorus percentages in the second and fourth columns, where the maximum variation is 0.004 %.

The tests of the three medium carbon contracts show very uniform results, irrespective of process, corresponding to the uniformity of analysis, except that the percentage of extension in the case of the basic Bessemer steel is considerably higher than that obtained with either the Bessemer acid or open-hearth basic processes. A singular feature of the test results, for which the writer is unable at present to find a satisfactory explanation, is that, whereas the Bessemer acid test deflections in both contracts average a lower figure than those for the corresponding open-hearth basic contracts, the open-hearth basic process in both cases shows a greater ultimate strength under the tensile test than the Bessemer acid steel. This difference in the case of the medium carbon contracts is very small, but in that of the high carbon contracts it is considerable. In connection with the tensile tests it should, of course, be emphasised that the highest ultimate stress corresponds to the lowest percentage of extension and contraction, and *vice versa*. As regards failures under test, no Bessemer basic cast was rejected on account of failure of any picee of rail to withstand the prescribed tests. In the Bessemer acid medium carbon contract one falling-weight test piece broke on the first blow, owing to a bad flaw, but re-tests proved the cast to be of satisfactory quality. A rail of another cast, however, broke during the course of straightening, without adequate reason for the fracture, and although the falling-weight test on this cast had been satisfactory, it was deemed advisable in the circumstances that the cast be rejected. All the casts of the medium carbon open-hearth basic and high carbon Bessemer acid contracts complied with the tests laid down, but one 50-ton high carbon open-hearth basic cast was rejected, both as the falling-weight test piece broke under the second blow, and also as none of three tensile test pieces showed more than 4 % extension.

Taking all these facts into consideration, it is evident that carefully made basic Bessemer steel comes quite satisfactorily out of this comparison with average rollings of steel rails made by the Bessemer acid and open-hearth basic processes. The test results show it to be of inferior hardness to the high-carbon steel made by the two other processes, but the limitation

of carbon content to 0.50 %, as a precautionary measure, is amply sufficient to explain this discrepancy. The general reliability of the rails, however, is apparent in the analyses and properties under test recorded in this article, while absence of brittleness is incontestible in that no falling-weight test piece was fractured, and also the average percentage of extension under the tensile test, as a measure of ductility, was the highest of all five processes.

[621 .33 (.81)]

Fuel cost key to Paulista Railway electrification,

By S. B. FORTENBAUGH,
TRACTION ENGINEER, GENERAL ELECTRIC COMPANY.

Figs. 1 to 4, pp. 593 and 594.

(*Railway Review.*)

With a view to demonstrating the extent of savings due to the substitution of electric for steam power on the lines of the Paulista Railway, Brazil, a careful investigation of all the problems involved was recently made, which gives some interesting comparisons between American and South American railway practice. The first electric locomotives were placed in operation on this line on 23 October 1921 and have since been handling a portion of the traffic over the electric zone.

From investigations of Brazilian steam railway practice it is found that the work done by one ton of coal is equal on the different railways to that accomplished by from 8.0 to 9.3 m^3 of wood. For the purpose of this discussion it is assumed that 8.5 m^3 of wood represents a fair average value, in work done, as the equivalent of one ton of coal. From the above figures we are, therefore, able to make direct comparison between the cost of coal and wood on the locomotive tender as against the equivalent cost per kilowatt-hour of delivered power. On this basis one cubic meter of wood burned on the steam locomotive is the equivalent in work done, to approximately 33.6 kw.-h. of delivered power. Figure 1 shows graphically the relation between the equivalent cost of power per kw.-h. and the cost of coal and wood on the locomotive tender.

Saving in fuel cost justifies expenditure for electrification.

The average annual cost of wood per cubic meter on all lines of the Paulista company for the years 1911-1920, inclusive, is shown on figure 2, the dotted portion of this curve showing an estimate of the probable minimum increase in cost during the next five years. This figure also shows the equivalent cost of power, in work done, corresponding to the actual cost of wood during this period. These curves indicate a possible reduction in the total cost of fuel, based on the contract price for electric power. This is a very large percentage of the total operating expense, and clearly shows the wisdom of the Paulista company's decision to substitute electric for steam traction. The indications are that the savings effected in fuel only will more than fully justify the capital expenditure required for electrification.

Figure 3 gives the Paulista Railway's operative cost for conducting trains over all lines for the year 1916-1920, and the estimated costs for the same period, assuming electric operations.

The most casual inspection of this data and the chart shown in figure 3, shows clearly the magnitude of the possible savings and that it is very largely a question of the cost of fuel versus the cost of electric power.

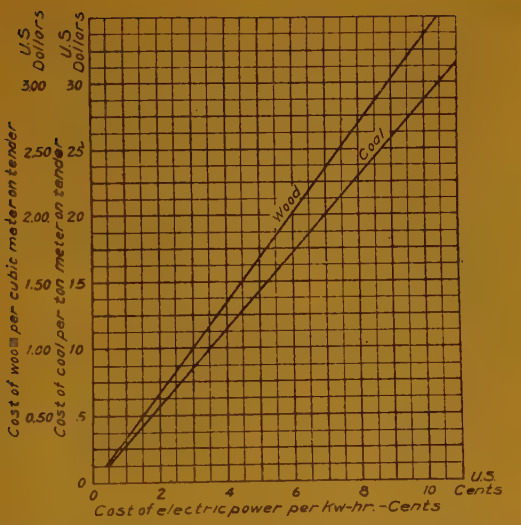


Fig. 1. — Comparative curves showing the cost of wood and coal on the tender and the cost of electric energy at the substation doing the same work.

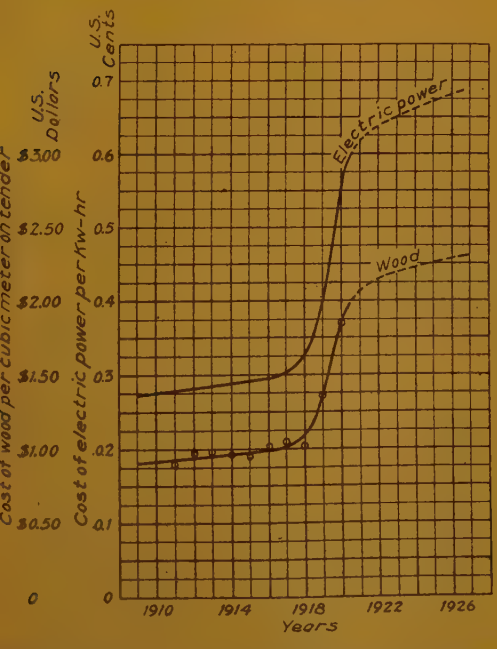


Fig. 2. — Cost of wood per cubic meter on tender and equivalent cost of energy per kw.-h. at sub-station.

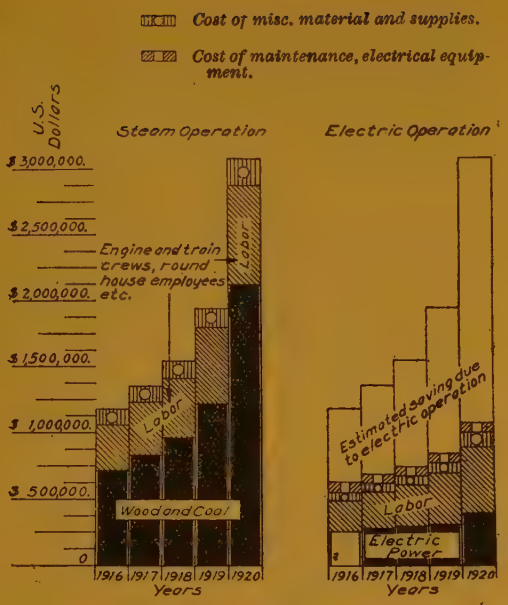


Fig. 3. — Comparative costs of conducting trains: All lines.

This comparison is based directly on the curves in figure 2, showing the actual cost of fuel to the Paulista company during this period, and therefore admits of very little, if any, modification. Any such possible or probable changes can only result from a slight variation in the conversion factors used, and at the most, are relatively insignificant.

Estimate reduction in wage expense and non-productive tonnage.

The estimated cost of the operating force — engineers, firemen, train crews, etc. — for the electric service has been assumed at two-thirds of the actual value under steam operation. Experience has conclusively shown that the savings to be expected by the increased speed, heavier trains, reduced engine and train mileage, etc., are well within the limit suggested. The marked reduction in the cost of miscellaneous material and sup-

plies, including roundhouse charges, the entire elimination of the water tanks, ash pits, etc., will effect an estimated saving in these items of not less than 50 % in favor of the electric service.

Approximately 86 % of the total tonnage hauled by the railways may be regarded as fundamentally common to both steam and electric operation. The remaining 14 % includes steam locomotive fuel, locomotive tenders and locomotive non-driving weight. The tonnage eliminated by the substitution of hydro-electric power for steam locomotives is equivalent to approximately 20 % of the revenue producing freight traffic. In other words, the same railway operated electrically will carry approximately one-fifth more revenue producing freight tonnage with no increase in the operating expense or track congestion. Consequently, the cars now used for transporting fuel on the Paulista Railway will make a valuable addition to their revenue producing equipment.

30 kw.-h. required per 1 000 metr.-tkm. on Paulista Railway.

The initial contract for electrical equipment includes only the material

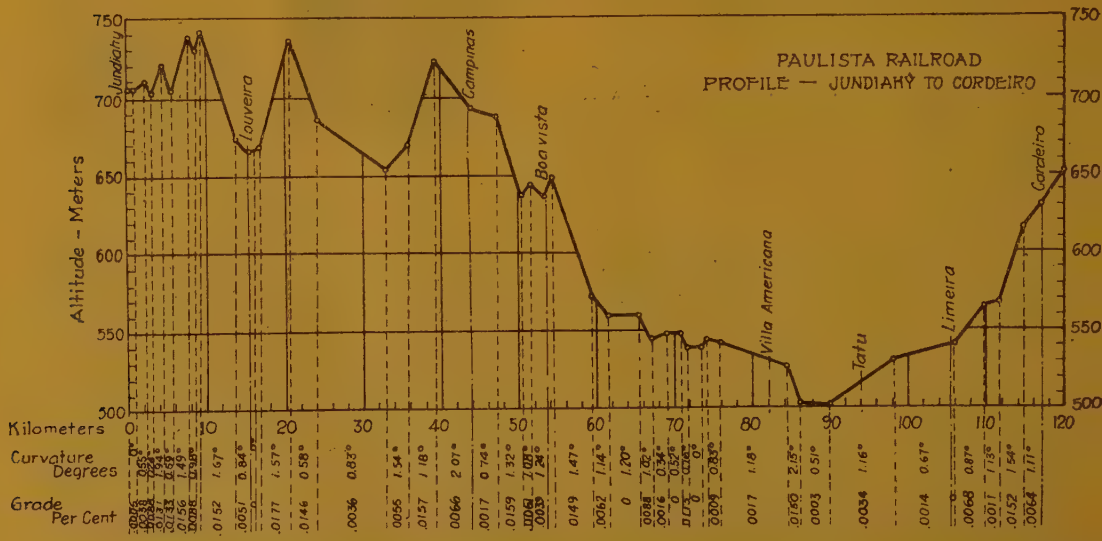


Fig. 4. — It is estimated that 1 000 gross metric ton-kilometres including weight of the electric locomotive can handled over this profile of the Paulista Railway with an average expenditure of not more than 30 kilowatt-hours.

and equipment necessary for the electrification of the main line, double track section between Judiahy and Campinas, a distance of approximately 44.0 km., but in planning this project the electrical engineers assumed an early extension of the electrified zone as far as Sao Carlos, a distance of approximately 206 km., and the general design and arrangement of the initial equipment is entirely suitable and adequate for this ultimate extension of the service, provision having been made for an ultimate increase of approximately 100 % in the 1918 revenue freight service. The accompanying table gives a summary of the proposed train service from the Paulista railway train diagram, as well as

the approximate substation net kilowatt hours output. The calculated values for energy consumption shown in this table are net values based on « through runs » between Jundiahy and Sao Carlos, with no allowance for the usual stops, switching, etc., incidental to the regular commercial service.

Train service and energy consumption : Freight service.

—	Jundiahy-Campinas.		Campinas-Sao Carlos.		Totals.
	Import.	Export.	Import.	Export.	
Number trains per day. . .	21	21	12	12	66
Locomotive-kilometres . . .	924	924	1 946	1 946	5 740
Trailing load-tons	400	700	400	700	...
Gross train weight tons . .	491	791	491	791	...
1 000 tkm..	454	731	950	1 539	3 680
Kw.-h. per tkm.	22	23	23	16	...
Substation kw.-h.	9 990	16 810	21 190	24 620	73 410
Per annum (300 days) :					
Locomotive-kilometres . . .	277 200	277 200	583 000	583 800	1 722 000
(1) 1 000 tkm..	136 200	219 300	286 800	461 700	1 104 000

(1) Includes weight of the locomotive.

Train service and energy consumption : Passenger service.

—	Jundiahy Campinas		Campinas-Sao Carlos.		Totals.
	Import.	Export.	Import.	Export.	
Number trains per day. . .	6	6	5	5	22
Locomotive-kilometres. . .	265	265	810	810	2 150
Trailing load-tons	400	400	400	400	...
Gross train weight tons . .	509	509	509	509	...
1 000 tkm	135	135	412	412	1 094
Kw.-h. per tkm..	23	26	26	18	...
Substation kw.-h.	3 110	3 510	10 710	7 420	24 750
Per annum (300 days) :					
Locomotive-kilometres . . .	96 725	96 725	295 650	295 650	784 750
(1) 1 000 tkm..	49 275	46 275	150 380	150 380	399 310

(1) Includes weight of the locomotive.

From the operating data available it is estimated that 1 000 gross metric ton-kilometres can be handled electrically over the Paulista profile with an average expenditure of not more than 28 to 30 kw.-h. This figure assumes an average for all classes of main line service, freight, passenger, mixed, etc., and includes the usual amount of additional power required for switching and all miscellaneous purposes. This amount of energy can be produced in a modern generating station with the consumption of approximately 70 to 75 lb. of coal burned at the rate of 2.5 pounds per kw.-h. It corresponds, furthermore, to the equivalent amount of work which can be done by approximately 0.85 of a cubic metre of wood on the steam locomotive tender.

MISCELLANEOUS INFORMATION

[656 .223.2]

1. — An account of a new system of wagons suitable for running on lines of different gauge, by simply changing the wheels and axles.

(Patented by B. Puig, engineer, Barcelona.)

Figs. 1 to 13, pp. 599 to 603.

1. — In order to avoid reloading, the problem of passing the wagons of one railway system over another of different gauge, has been solved in the United States by substituting under the main frames, complete bogies suitable to the track on which they have to run.

The type of bogie wagon in general use in the United States is only used to a very limited extent in Europe, where the ordinary rolling stock is carried on two or three pairs of wheels. It does not appear that any method has as yet been put into practice on the important lines here, in order to permit the passage of wagons from one gauge to another.

The wagons with extensible bogies used on the Chinese railways (see the *Génie civil*, No. 23 of 1909, p. 420) can no longer, it appears, be regarded as current practice.

2. — One may mention, however, the measures taken by builders of rolling stock, in countries using the standard gauge, to send new stock destined for Spain (gauge 1 m. 675 [5 ft. 6 in.]), or for Russia (gauge 1 m. 524 [5 feet]) : The wheels are temporarily keyed on the permanent axle to the standard gauge, to allow the vehicle to travel as far as the Russian or Spanish frontier, where the wheels are then moved and finally keyed to the other gauge. Such a procedure is quite justifiable for running empty, but it entails, when running on the standard gauge, a much greater stress in the axle, owing to the increase in the overhang, and is therefore inadmissible for wagons under load.

3. — Mr. Blancquaert, a reporter on this question at the third (1889) session of the International Railway Congress, is of the opinion that « For vehicles with two or three pairs of wheels, and not fitted with brakes, and requiring to pass from the standard gauge to the Russian gauge, the problem may be solved by changing the pairs of wheels, because in this case the overhang of the journals differs but slightly for one or the other axle. In order to pass however from the standard gauge to the Spanish gauge, it is hardly likely that one could arrive at a practical solution by this method with the ordinary rolling stock, the difference between the gauges being too great (1) ».

Indeed, the overhang of the point of application of the load on to the journals outside the point of support of the rails is increased by about 50 % for the Spanish axle, running on the standard gauge; the stress in the axle will thus be increased in the same ratio unless the *total* weight carried by the axle is reduced by about one third. If T is the total tare of a wagon, E the weight of the wheels and axles, C is the *permissible* load when on the Spanish gauge, it is easily seen that the *permissible* load on the standard gauge will have the value $X = \frac{2}{3} C - \frac{(T - E)}{3}$. If C = 20 tons, T = 10 500 kgr. and E = 2 475 kgr.,

(1) See the *Bulletin du Congrès des chemins de fer* of April 1889, p. 312, and *Compte rendu général de la troisième session* (Paris 1889). vol. II, p. IX-3.

then X is not more than 10 658 kgr. so that $\frac{X}{C} = 0.533$.

For the 15 ton wagons having a tare of 11 460 kgr., and with the wheels and axles weighing 2 200 kgr., this ratio is still less, X′ being equal to 6 913 kgr., and $\frac{X'}{C'} = 0.461$.

Wagons of these types would thus be used under extremely unfavourable conditions from the point of view of loading. Furthermore, such a method would entail a considerable diminution of the coefficient of stability, when on the standard gauge, in consequence of the increased overhang of the point of application of the load on to the journals, outside the width of the track, a state of affairs very disadvantageous to running at high speeds.

4. — *Puig's patents* provide for the construction of a special 20 toon wagon of the Spanish type, so arranged as to *allow the wheels and axles to be changed easily* when passing from one gauge to another without encountering the difficulties referred to in the preceding paragraph.

The transverse distance between the *axle guards* of these wagons is the mean of the distances between the centre points of the journals of the axles corresponding to the two gauges. The distances between the centre points of the journals being 1 m. 940 (6 ft. 4 3/8 in.) and 2 m. 212 (7 ft. 3 1/16 in.) respectively for the standard gauge and for the Spanish gauge, the distance between the centres of the axle guards will be $\frac{1.940 + 2.212}{2} =$ 2 m. 076 (6 ft. 9 3/4 in.), so that if the thickness of the axle guard is 20 mm. (13/16 inch), the distance between the exterior faces of the axle guards will be 2 m. 096 (6 ft. 10 1/2 in.), and this dimension fixes the distance between the *insides* of the sole bars.

The *springs*, when running on the Spanish gauge, are situated, as in ordinary practice, outside the axle guards; for running on the standard gauge, however, these springs are removed and replaced on the other side of the axle guard towards the *inside* of the frame. The semi-difference $\frac{2.212 - 1.940}{2} = 0$ m. 136 (5 3/8 inches), which is the distance between the centre points of the journals for the two gauges, is also the distance between the centres of the two positions of the spring, thus, the centre of the spring is $\frac{0.136 - 0.020}{2} =$ 0.058 (2 5/16 inches) from the face of the axle guard, either on one side or the other, thus allowing springs having plates 100 mm. (3 15/16 inches) wide to be used, whilst providing a sufficient clearance of 8 mm. (5/16 inch) between the spring and the axle guard (figs. 1 to 5).

This arrangement requires the provision of two *spring supporting brackets*, one for when equipped for running in Spain in the ordinary position under the sole bar, and the other for when running on the standard gauge, situated inside the axle guards. These two brackets carry one and the same bolt and three suspension links, two on the outsides and one in the centre, this latter being used in both cases. A catch is provided to hold these suspension links in a horizontal position when not in use (fig. 4).

The *axle boxes* suitable for axles of the Spanish, or standard gauge respectively, have the grooves in their sides in quite different positions in each case, but it is evident that one single type of axle box will suffice, provided that it has two symmetrical grooves with their axes spaced 136 mm. (5 3/8 inches) apart. For the Spanish axle, it is the grooves situated at the back of the axle box which will be used; for the standard gauge it is those situated at the front of the axle box.

5. — *Other particulars* of this type of wagon.

The *axle guards* are of the usual type with open arms, so as to leave the springs quite visible when they are mounted on the inside for running on the standard gauge, in order to facilitate examination (fig. 1).

The *springs* must be able to be detached easily from their supports when the axles are lowered out, and to readily re-engage when the substituted axles are put into place. For

this reason, the *top plate*, instead of being rolled into a ring at its ends, terminates in an upturned portion shaped in the form of a beak so as to engage easily

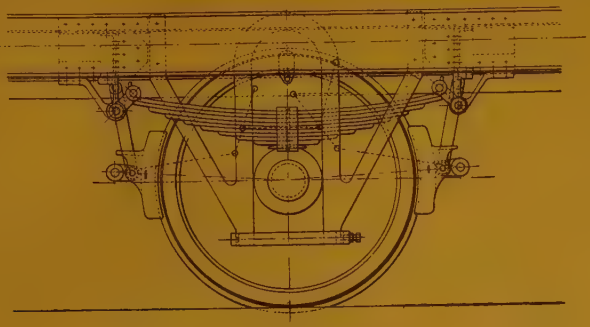


Fig. 1. — Side elevation.

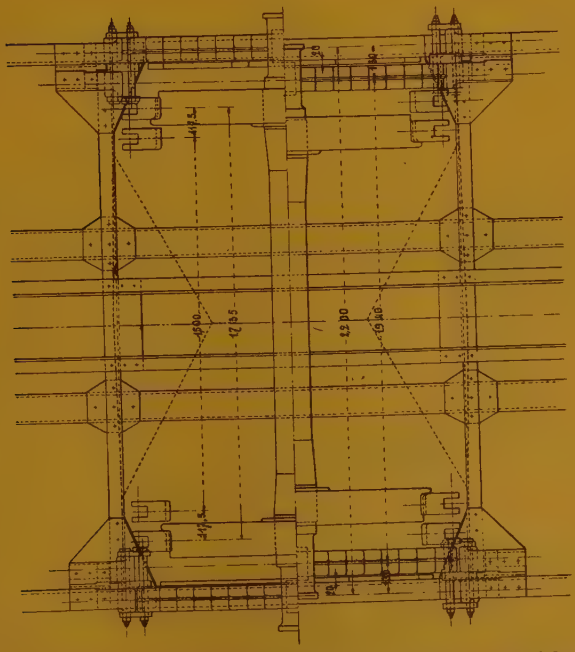


Fig. 2. — Plan of frame. Left hand side, arranged for Spanish gauge.
Right hand side, arranged for standard gauge.

with the supension links (fig. 4). While the wheels are being changed, the spring remains suspended by its buckle on a chain fixed to the sole bar; this chain is sufficiently long to allow the spring to be passed beneath the arms of the axle guard (fig. 6). The spring buckle engages freedly in recess in the top of the axle box, which, with this end in view, is furnished with four small iron guides, slightly inclined and fixed in the cast iron of the axle box (fig. 7).

The *axle guard stay* must be easily remo-

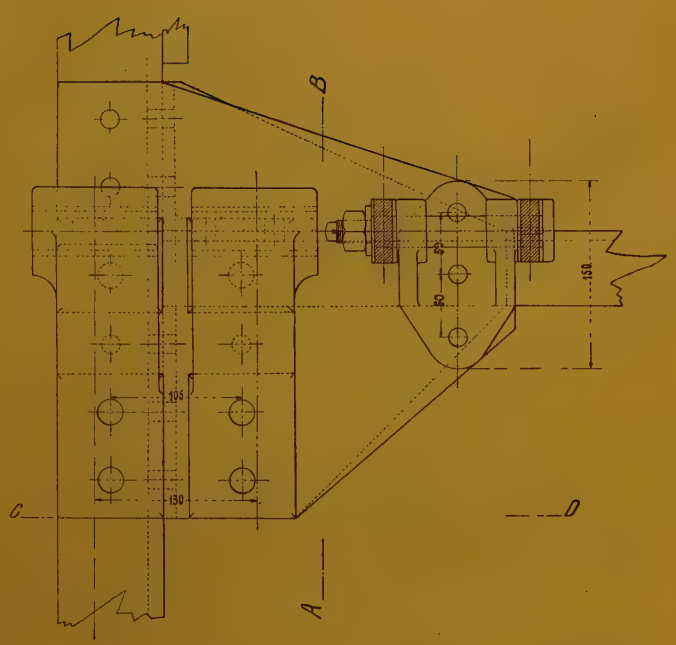


Fig. 3. — Plan, viewed from beneath through line E. F. G. H. of figure 5.

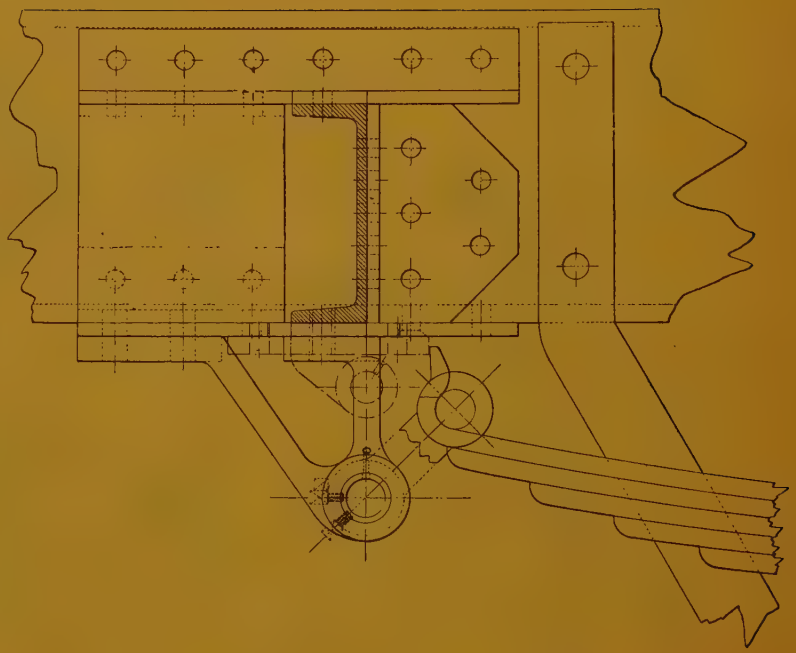
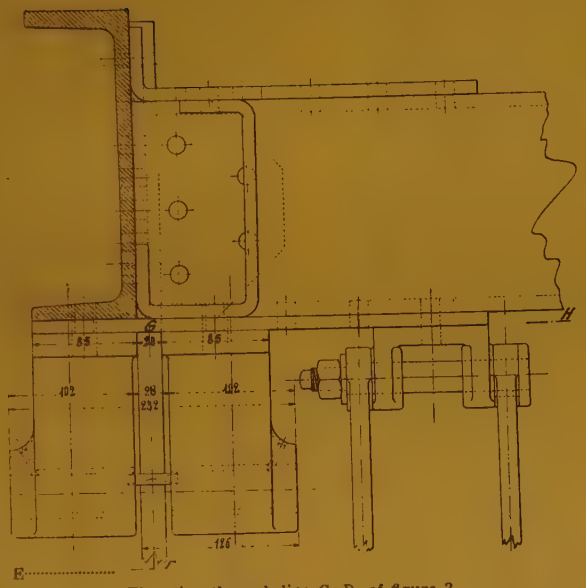


Fig. 4. — Elevation through line A. B. of figure 3.



Elevation through line C. D. of figure 3.

Fig. 5. — Supporting brackets for spring and brake blocks.

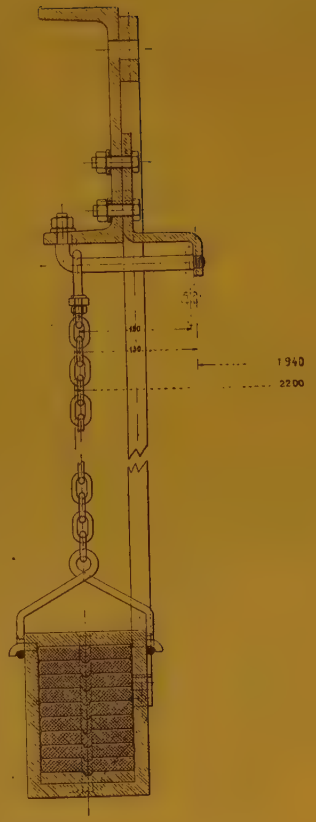
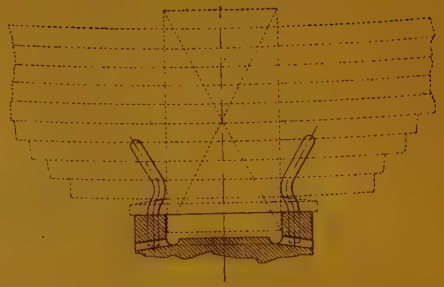
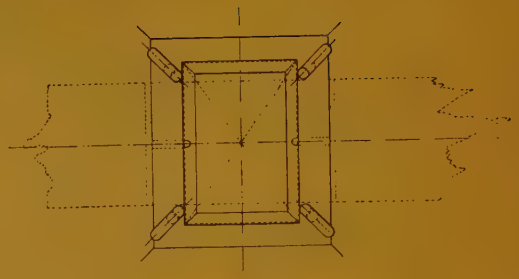


Fig. 6.
Cross section of spring.

Longitudinal section.





Plan.

Fig. 7. — Axle box socket for spring, with self seating guides.

Fig. 8. — View from back.

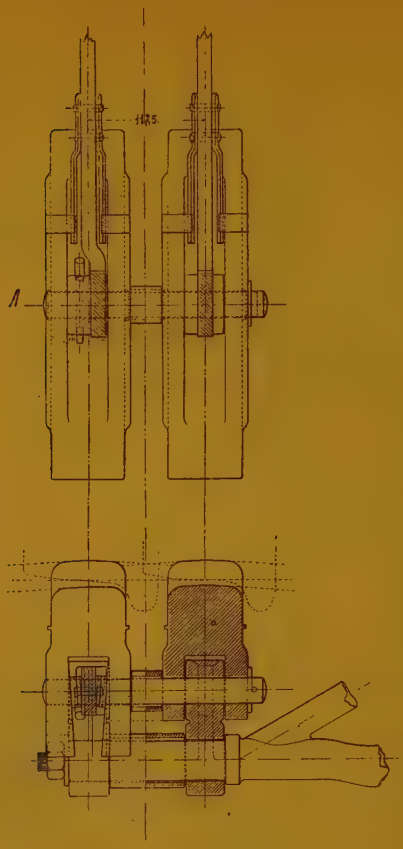


Fig. 9. — Side view.

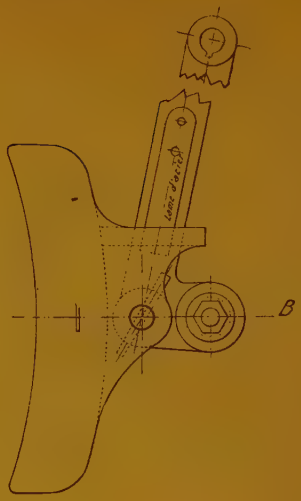


Fig. 10. — Plan and section through line A. B.

Figs. 8 to 10. — Brake blocks and their suspension.

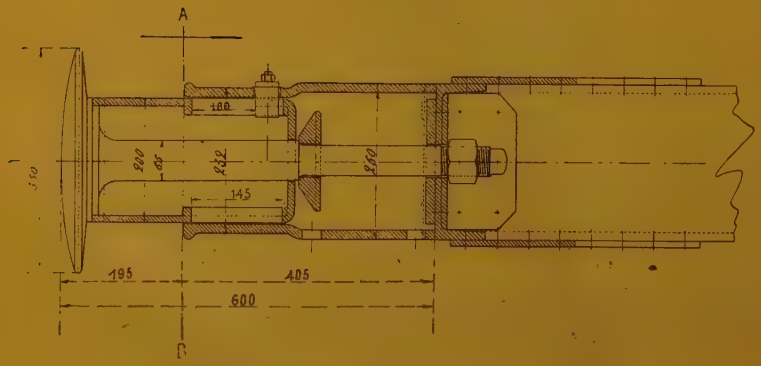


Fig. 11. — Longitudinal section.

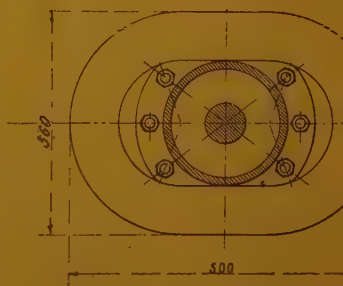


Fig. 12. — Cross section through

Figs. 11 and 12. — Buffer, double guided by spindle and plunger.

vable in order to change the axles. It is fixed to the arms of the axle guard by a set screw, the head of which is held in place by a stirrup.

The *axle boxes* are balanced by means of a mass of metal formed in the casting or inserted in such a way as to permit their rotation upon the journals when they are not held between the arms of the axle guard.

The *brake arrangement* consists of two brake blocks placed side by side, one for the Spanish gauge and the other for the standard gauge. They are mounted on the ends of the same brake beams, and are each suspended by a hanger. The blocks are kept in position by strips of steel fixed on the brake hanger and rubbing against the inside cheeks of the brake block (figs. 8 to 10).

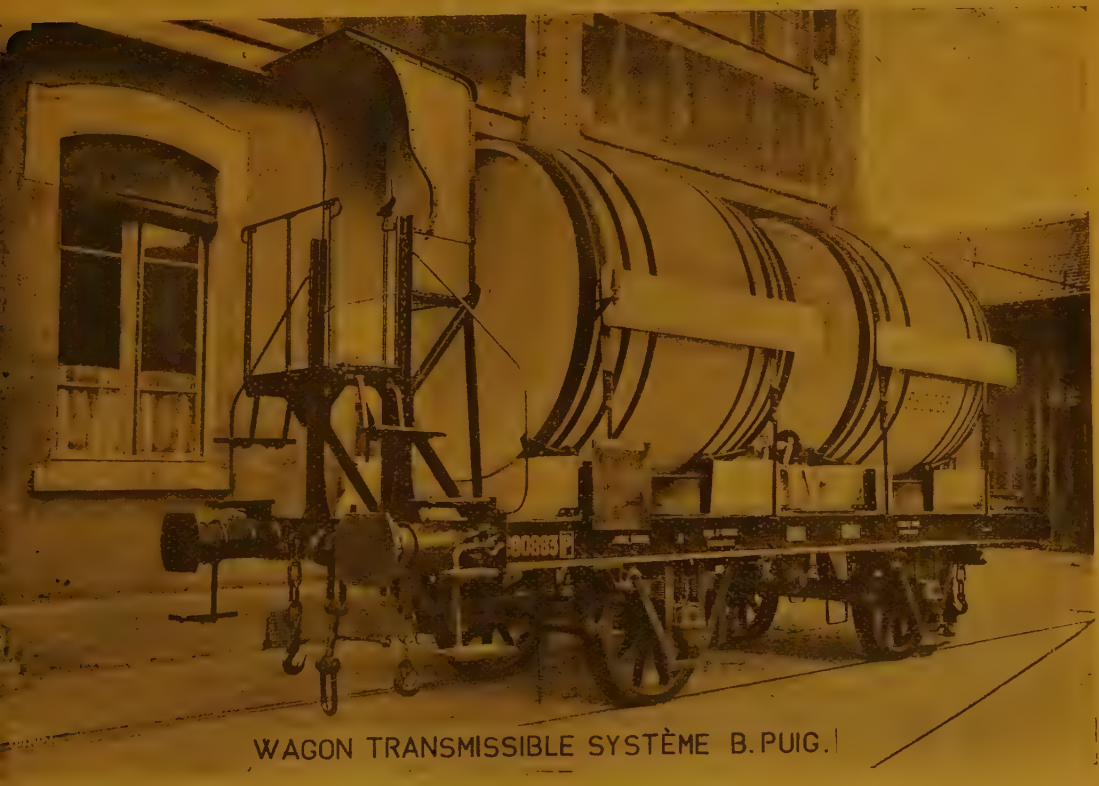


Fig. 13. — B. Puig's transferable wagon.

The distance between the centres of the *buffers* is the mean between the maximum dimension allowed by the Berne Convention (1 m. 770 [5 ft. 9 11/16 in.]) and that which is usual in Spain (1 m. 950 [6 ft. 4 3/4 in.]). This distance is thus $\frac{1.950 + 1.770}{2} = 1$ m 860 (6 ft. 1 1/4 in.). The buffer heads have a minimum breadth of 0 m. 340 (1 ft. 1 3/8 in.) (Berne Convention minimum) $+ \frac{1.950 - 1.770}{2}$ = say 0 m. 430 (1 ft. 5 in.). Moreover, the plungers are guided both by the buffer casing and by a centre spindle (figs. 11 and 12).

6. — The *exchange of axles* is performed by means of an arrangement similar to that used for changing bogies, known as a *Ramsay pit*. Essentially, the pit has four rails for the two gauges, and on each side is a narrow gauge track on which run carrying trucks and transverse girders, resting on these trucks, carry the wagon during the operation. By lifting the whole above the pit, the wheels for the Spanish gauge, for example, are separated from the wagon, and the wheels for the standard gauge are then brought and placed beneath the wagon.

7. — A wagon with these characteristics was under construction in France in 1914. It was requisitioned by the French Army Supply Service and ran on the lines of the Midi Company. It appears to have given every satisfaction as regards its working on the standard gauge.

We give (fig. 13) a reproduction of a photograph of this vehicle.

[621 .33 (.45)]

2. — Valtellina Railway is extended (1).

Fig. 14, p. 605.

(*Electric Railway Journal.*)

The Valtellina Railway may be considered the father of trunk line electrified roads in Europe. The fuel scarcity was always felt in Italy, and this, combined with the abundance of water powers, was no doubt responsible for early and exhaustive tests with electric traction. In the beginning the Italian engineers adopted the three-phase system, because at that time the three-phase induction motor was the only reliable railway motor in existence other than the low-voltage d. c. motor. The system originally installed by Ganz & Company of Budapest has been developed and improved to give the system of to-day, which reprensents a very high standard in electrified operation, although rather costly from an installation standpoint. To abandon the three-phase system in favor of a possibly better one would result in a tremendous loss of time, valuable experience and money.

The Valtellina road is not only of great technical and historical interest but also is one of the electrifications that represents an extremely good solution of a difficult traffic problem. The road was built in 1902, and many articles have been published previously describing its equipment. The total length of the road is at present 65.7 miles and is single track throughout. It is the connecting link between Milan and several famous Alpine summer resorts. Its main traffic consists of tourists, freight transportation never being of great importance. The road passes over a very mountainous territory; about one-third of the line passes through tunnels, one-half of it is in curves, and there are grades on the system as great as 2.2 %. All of the original equipment was furnished by Ganz & Company. Two hydro-electric power stations supply three-phase power at 15 cycles and generate directly at 20 000 volts.

Originally there was only one feeder line parallel to the road, but many interruptions of the service, due to the breakdown of the feeder, forced the road to install a second parallel three-phase feeder consisting of three copper wires, each about 0.4 inch in diameter (160 000 circ. mil), suspended on seamless steel tube masts. Along the tracks are distributed nine transformer stations, each containing one 300-kv.-a. three-phase transformer, which reduce the feeder supply voltage of 20 000 to the trolley voltage of 3 000. These transformers are of a very liberal design and will withstand for short periods 500 % overload or 1 500 kv.-a.

(1) Dr. E. Huldschiner contributes to *Elektrotechnische Zeitschrift*, issues of 26 March and 2 June 1921, an article on a recent extension of the Valtellina Railway. From this article the facts herewith are taken.

Original suspension and equipment.

Two No. 0 copper wires suspended 19 ft. 6 in. above the rails constitute the old trolley line. The wires are held in movable insulators made of Ambroin (a material similar to Bakelite). These insulators are held on a steel wire between two porcelain insulators.

The original rolling stock consisted of two locomotives and ten motor cars, but this equipment proved inadequate at the end of the first year of operation, and three new type locomotives were installed of the 1-C-1 type. In 1906 four more Ganz locomotives and three Brown-Boveri locomotives were added. From year to year the traffic grew denser, until in 1914 the normal daily schedule consisted of thirty-nine passenger and forty-nine freight trains.

Details of the new extension.

The new extension of the line from Lecco to Monza has a length of 23.1 miles, 4.3 miles of which is double track. This extension brings the Valtellina system to within 8.6

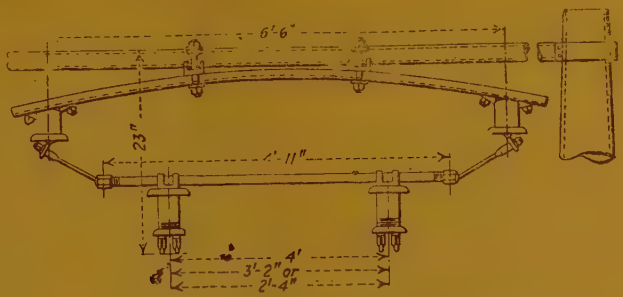


Fig. 14. — Standard overhead construction for three-phase lines : Italian State Railway.

miles of Milan. The power for the extension is supplied from an old power house in Robbiate, which was enlarged to its present capacity of 30 000 kv.-a. The feeders are cables made of three copper wires, each about 0.6 sq. in. diam. (360 000 circ. mil) in cross-section. Three new transformer stations, each equipped with a bank of three single-phase transformers rated at 2 250 kv.-a., were erected along this line. To care for emergencies a 430 kv.-a. portable substation was developed and can be dispatched and used at any point on the lines.

The trolley suspension on the new length is somewhat different from and heavier than that on the other portions of the system. It represents the standardized equipment of the Italian State Railway, as shown in the accompanying cut. An interesting detail is the method by which the joints between the porcelain and the hardware are made. To obviate cementing, a layer of hard rubber is deposited on the inner side of the porcelain, upon which is placed an electrolytic layer of copper. This copper layer is then threaded to take the suspension steel bolt. This process is somewhat expensive, but makes a very dependable joint, free from any danger of cracking. The trolley lines are very heavy, each having a cross-section of about 1.5 square inches with two wires for each phase, or a total cross-section of 6 square inches for each track. In order to carry the great weight of the trolley line and care for the many curves, steel masts have been erected every 65 feet. Every tenth pole is connected to the rails. The rail bonds are made with the Brown-Boveri metal paste method. Great care was taken to construct the overhead wiring at switch points, which is quite a complicated matter for three-phase systems. The construction is somewhat heavy but has given good satisfaction. On the present terminal station at Lecco there are not less than fifty switch points. Very heavy

overhead construction is necessary in stations. For example, there are spans of 108 feet over nine tracks and also the overhead construction for six tracks, suspended from one pole which is located in the center. Some of these spans appear rather light but seem to give good service.

Latest type of locomotives.

Three new types of locomotives have been ordered for the extension, which operate, however, over the entire line. Of especial interest is the Westinghouse type 1-C-1, a description of which has not been published previously. The main characteristics of this locomotive are :

Diameter of driver	64 inches.
Diameter of pilot wheels .	38 inches.
Length over all	36 ft. 2 in.
Total weight	161 000 lb.
Weight of mechanical parts	72 732 lb.
Weight of electrical parts.	88 160 lb.
Speed at 16 2/3 cycles . . .	23, 31, 46 and 62 miles per hour.
Hour rating	450, 1 670, 2 600 and 2 200 H. P.
Maximum tractive effort at periphery of drivers .	26 400 lb.
Specific output	32.5 H. P. per ton of weight.

All three driving axles have considerable side play, the center one of 1 inch, the two outer 0.8 inch. The weight of the frame rests upon heavy leaf springs, capable of supporting a weight varying between 45 and 15 tons. Power is transmitted from the two motors to the cab by a triangular rod construction of the Kando system. The motors are not fixed solidly to the frame, but rest upon very heavy spiral springs. Each motor has four bearings, which permits of a very narrow air gap of about 0.078 inch. A removable floor construction permits the installation of the motors from above. There are two compressed air operated pantographs on the roof, as is standard for Italian railways. An auto-transformer is used to change the three-phase supply at from 3 000 to 3 300 volts into two-phase supply at from 3 300 to 3 600 volts. The main motors have a maximum hourly rating of 950 kv.-a. each, are asynchronous, give four speeds, and have a wound rotor with four collector rings on one side and three rings on the other side. These rings are located outside of the bearings and beyond the crankshaft which calls for hollow shafts. Four economic speeds can be obtained by operating the two motors either as eight-pole three-phase, or six-pole two-phase, and in each case either in parallel or in cascade. The stators and rotors are wound with twelve coils on each, and every three of these coils form a star connection.

Starting equipment and test results.

The motors are started by means of an electrolytic starter with stationary electrodes. Air pressure causes the liquid to rise or fall. The locomotive has, for this purpose and for the operation of the brakes, two air compressors, taking in 35 cubic feet of air per minute and compressing it to 6 atmospheres. Each compressor consists of two pumps and two motors, although one set is sufficient for normal operation.

Tests of a very severe character gave very good results. The temperature rise of the motor copper at a train speed of 46 miles per hour and with the locomotive pulling 21 000 lb. for one hour was 69.5° C. With a train of 383 t. and up a grade of 1.1 %, the locomotive accelerated to 43.5 miles per hour in 267 s. The locomotive shows a consumption of about 35 w.-h. per ton mile. The other locomotives added to the equipment have been previously described and are of the 2-C-2 Brown-Boveri and Oerlikon types. The main dimensions and weights of this type of locomotive are :

Diameter of drivers	64 inches.
Diameter of pilot wheels.	38 inches.
Length over buffers	43 ft. 10 in.
Total weight.	202 750 lb.
Weight on drivers.	99 100 lb.
Weight of mechanical parts	110 200 lb.
Weight of electrical apparatus . . .	92 550 lb.

[625 .232 (.71)]

3. — New sleeping cars for the Canadian Pacific.

Figs. 15 to 18, pp. 608 to 610.

(*Railway Mechanical Engineer.*)

In handling its through passenger business the Canadian Pacific is confronted with some interesting problems. The road has the advantage of a fine scenic route and with a line extending from coast to coast, is well situated to secure transcontinental passengers. On the other hand, the competition for Pacific Coast traffic is very keen. Furthermore, the prospect of the journey of 2 886 miles between Vancouver and Montreal, requiring four and one half days to complete, might seem unpleasant to inexperienced travellers. The hotels conducted by the company at intervals along the route afford an opportunity for breaking up the journey, but even so the character of the traffic demands that the passenger equipment be of the highest grade, provided with every facility for the comfort of travellers. These conditions were carefully considered by the railroad in drawing up the designs of the latest order of 12-section and compartment sleeping cars. As a result the cars have been fitted with numerous conveniences not found in the ordinary sleeping car.

One of the notable features of the 12-section type sleeping cars is the provision made for the comfort of women passengers. This is particularly desirable in the transcontinental service on account of the length of the runs and because the proportion of women in tourist traffic is greater than where the cars are used principally for business trips. The ladies dressing room is unusually commodious. It is fitted with three wash stands, each of which has a light above it, and is provided with a three panel, adjustable mirror. A long mirror is also fitted in the saloon door. One of the innovations which should contribute materially to the comfort of women passengers is a couch which has been installed in the dressing rooms on some of these cars. This provides an opportunity for relaxation that would seem highly desirable in view of the somewhat uncomfortable form of the usual sleeping car seat.

The new equipment consists of 69 sleeping cars, 56 of the 12-section type and 13 of the 10-compartment type. All the cars are constructed with steel frames and wood interior finish. The frames and trucks were built by the Canadian Car & Foundry Company at Montreal and the interior fittings were applied at the Angus shops of the Canadian Pacific.

On account of the special features of the design, the 12-section sleeping cars are extremely long, the length over the body end sills being 75 ft. 6 in., and the coupled length 83 ft. 10 1/2 in. The truck centers are spaced 59 ft. 6 in. apart and the wheel base is 70 ft. 6 in. The height from the rail to the top of the roof at the center is 14 ft. 3/4 in. and the extreme height, from the rail to the top of the heater jack, 14 ft. 6 1/2 in. The width at the eaves is 10 ft. 1 1/2 in. and over the side sheets 9 ft. 10 in. The average weight of the cars is 173 400 lb.

The underframe is built with a deep fish belly center sill and Z-bar side sills. The center sill has a maximum depth of 30 inches. between crossbearers for a distance of 28 feet and is 15 inches deep at centerplate. The web plates are 5/16 inch. thick and are spaced 16 inches apart. At the bottom they are reinforced by two 3 inches by 3 inches by 3/8 inch angles on each plate, while the stiffening at the top consists of one 6 inches by 4 inches by 5/8 inch angle placed outside each plate with the short flange horizontal. A top cover plate 30 inches wide by 9/16 inch thick extends continuously for practically the full length of the sill, the ends reaching just beyond the door posts.

The body bolsters are of the double type commonly used with six wheel trucks, of built up construction, the two arms being 4 ft. 8 in. apart. The cross bearers, which are spaced

15 ft. 9 in. from the center plate, are also built up of pressings reinforced with angles and top and bottom cover plates, the construction being shown in the cross sectional drawing. The floor beams are pressed from 5/16 inch plate, the spacing varying from 16 inches to 3 ft. 1 3/8 in. The side sills are each made up of a 5 inches 11.6 lb. Z-bar and a 3 inches by 2 1/2 by 1/4 inches angle. The body end sill is a 5/16 inch pressing. An end cover-plate, 5/16 inch thick and 22 inches wide, extends across the underframe at each end. At the bolsters there are also 1/4 inch by 5 ft. 6 in. by 8 ft. 11 in. cover plates. The remainder of the floor is covered with 1/16 inch floor plates, which overlap the centersill cover plate on each side and fit over the floor beams and side sill.

Fig. 15. — One of the new sleepers leaving Angus car shop.

Side frame.

The side posts are of two types, those at the piers being of U-sections made right and left, the sheets being riveted to the flanges. The center pier posts are of a deeper U-section, the web being turned toward the outside of the car. The side plate is a Z-bar, 2 by 2 1/2 by 4 5/8 inches by 3/16 inch and is made continuous from end to end. The carlines are pressed of 1/8 inch steel. The lower carlines, which are continuous across the lower deck and up the side of the clerestory, are of 1/8 inch steel plate of U section, irregularly spaced at intervals of about two feet. A Z-shaped deck plate 1/8 inch thick is fastened to the inside of the clerestory. The upper carlines are of 1/8 in. steel of Z section, 4 3/8 in. high at the center and are placed directly above the lower deck carlines wherever possible. They are riveted to the inside deck plate and to the lower carlines. The body corner posts are built up of a 3 in. by 4 in. angle forming the corner with a 4 in. by 3 in. by 3 in. Z-bar riveted to the inwardly extending flange of the angle and forming a point of attachment for the end plates. The door posts are 6 in. I-beams to which wooden door frames are fitted. There are two intermediate posts on each side made up of 4 in. by 3 in. by 3 in. Z-bars, reinforced up to about two feet above the floor by 3 in. by 3 in. angles. The vestibule diaphragm posts are of 6 in. I-beams and are braced to the end posts of the body by 6 in. channels. The vestibule corner posts are made up of pressed steel with a wood filler.

The outside plates below the windows are 3/16 in. thick and meet the window ledge under the belt rail. The letter board and the

pier plates are 1/8 in. thick and the outer deck plates 1/16 in. thick. The roof sheets are 1/16 in. thick excepting the hood sheets, which are No. 12 gage galvanized.

The exterior of the cars is finished in Tuscan red, the railway company's standard colour.

Interior finish.

The fittings in the interior of the car have been designed to give a pleasing appearance and also to afford adequate insulation for the extremely cold weather encountered in Canada. Three thicknesses of insulation are used in the side walls and two thicknesses in the roof and the deck. The method of fastening the insulation in the deck is worthy of mention. Wire nails are attached to the sheets by spot welding the heads. The insulation is driven over the nails which are then bent over. The floor has one layer of insulation over which a double wood floor is laid, except in the passageways which have rubber floors and the saloons where tile is used. Steel plates form the inside of the wall up to the seat level and a third layer of the Salamander insulation is carried up to that point. The inside of the walls above are covered with wood wainscoting up to the lower edge of the berths. The side walls within the berths and the headlining are of Agasote. The berths, the deck moulding and the interior partitions are of wood.

All the woodwork is mahogany or mahogany finished, except in the men's smoking room where either English oak or black walnut has been used. All parts above the deck moulding are painted greenish gray. Little ornamentation is used. The ceiling and deck panels have a conventional border and marquetry borders are set into the berths and bulkheads. The seats are upholstered in green figured friezette plush and the carpet also is green. In the staterooms Biltmore plush is used for upholstery.

The men's smoking compartment has three wash basins, a dental lavatory and seats for six persons, upholstered in leather. The entrance to the men's saloon is from the hall instead of through the smoking room.

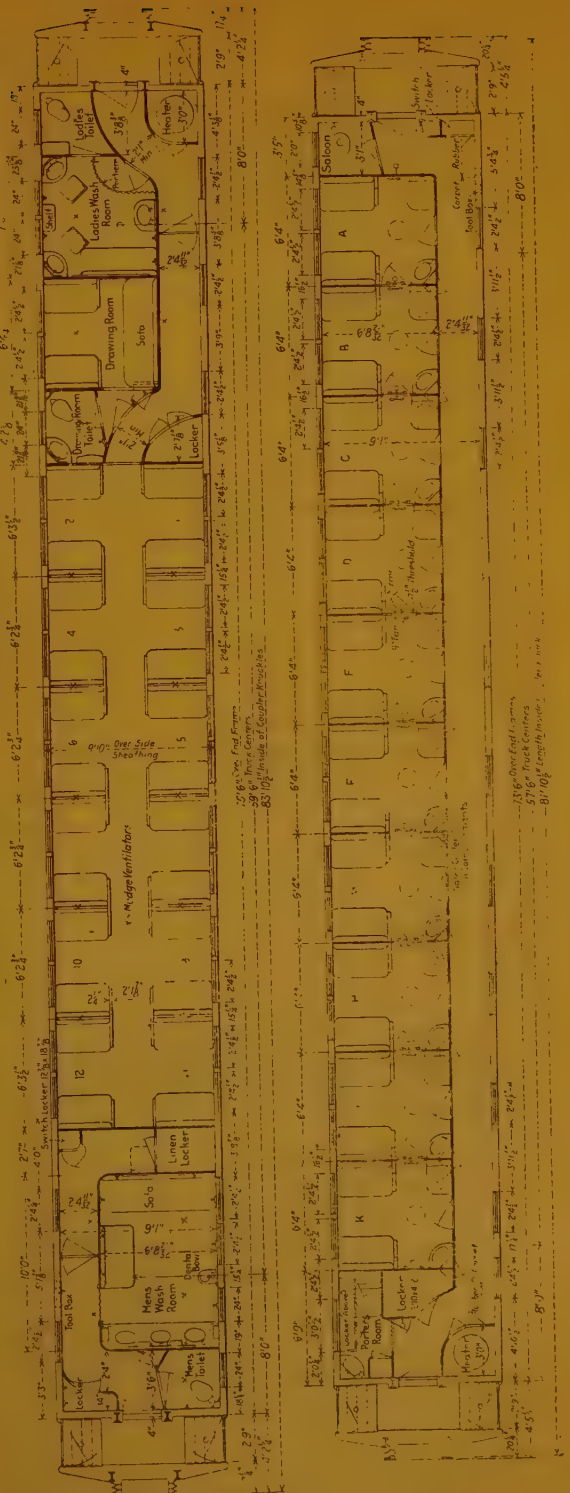


Fig. 16. — Floor plans of the twelve-section and ten-compartment cars.

Fig. 17. — Transverse section through the car body.

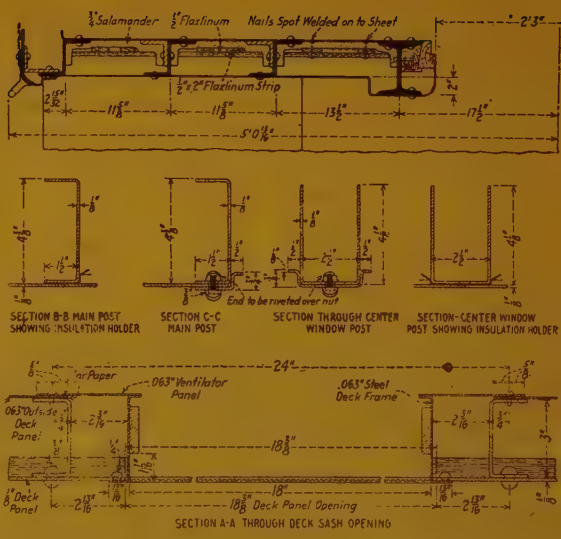


Fig. 18. — Horizontal sections through the car body.

The cars are heated by a combined vapor and hot water system with a Frumveller heater. The main piping has separate controls for each side of the car, for the stateroom and the smoking and dressing rooms. Additional heating pipes are provided which have individual regulation for each section. Twenty-one Mudge ventilators are applied to insure adequate air circulation.

The lighting systems are of the Safety and Stone-Franklin types. The batteries have a capacity of 600 ampere hours. The main lighting fixtures have semi-opaque bowls, five of this type being used over the berths and one in the stateroom. The usual arrangement of small lamps in the berths and aisle night lights is followed. The smoking room is fitted with a two-light ceiling cluster and individual lamps over the mirrors, while in the ladies' dressing room wall fixtures only are used. The conduits for the piping are set inside the walls and the roof.

The cars are carried on Commonwealth six-wheel trucks, with 5 by 9 inch journals, having a wheel base of 11 feet. They are equipped with steel tired wheels and clasp brakes. The brake equipment is the schedule

LN 1812 designed for 90 % braking power. Miner hand brakes are used with a sheave wheel between the drum and the brake rigging to increase the force.

Compartment cars.

In general design the compartment cars are quite similar to the 12-section sleeping cars. The body is two feet shorter and changes have been made in the spacing of posts to fit the altered floor plan. The interior woodwork is mahogany and the upholstery is Biltmore plush. Care has been taken in fitting the compartments to afford the maximum of comfort and convenience for the passengers. Individual regulation of heat and ventilation is provided. A long baggage rack, an umbrella rack, trays and numerous hooks are facilities that will appeal to the traveller with a large amount of luggage. Space at one end of the car has been utilized for a saloon while the other end carries the heater, linen locker and porter's room.

Both types of cars are equipped with safety appliances to meet the United States and Canadian standards. The handholds are attached so that they can be removed without disturbing the car framing, flooring or lining. Other appliances include bottom operating lower couplers, Miner A5P draft gear, Acme single web type diaphragms with rubber hoods, JM expander rings, Miner buffer and Woods single roller side bearings.

[621 .133.3]

4. — The locomotive boiler explosion at Buxton.

(*Engineering.*)

An explosion of the boiler of a railway locomotive is now fortunately a rare occurrence, and it is many years since we have had to report a disaster of so serious a character as one which took place on the London and North-Western Railway, Buxton, on Friday 11 November. In the early morning (12.45 a.m.) a goods train was just leaving the station on its way to Oldham when the boiler exploded with what is described as a « deafening roar ». The driver and fireman, who were on the footplate, were both blown away, and their bodies were subsequently found in a plantation 450 feet distant. They were terribly mutilated and were practically beyond recognition. Fragments of the engine were scattered in all directions and some embedded in the ground, it is stated, half a mile away; a portion of the permanent way was torn up and several wagons behind the engine were destroyed, while some windows in the vicinity were broken. The havoc occasioned was so great that it was some hours before a breakdown gang could clear the road for traffic.

On Wednesday 16 November, an inquiry by the coroner for the High Peak district was opened at the Town Hall, Buxton, an influential jury being empanelled, and various representatives of the London and North-Western Railway Company, the National Union of Railwaymen, and the Associated Society of Locomotive Engineers and Firemen were present. In the first instance the coroner read the evidence (previously taken) as to the identification of the deceased men, as follows :

James Greenwood, railway engine driver, Oldham, identified one of the bodies as that of his brother, Walter Fletcher, of Oldham, 28 years old, and fireman in the employ of the London & North-Western Railway Company. Witness was quite sure of identity because of the conformation of the teeth.

Georges Holmes, Oldham, identified the other body as that of his father, William Holmes, 50 years of age, engine driver, who had been in the employ of the London & North-Western Railway and had about thirty-two years' experience. Witness was quite sure that the grey sock worn by the deceased was his father's, and he also produced other tokens as proofs of identity, such as a knife, purse, etc.

The following evidence was then given :

John Hannah, Stockport, deposed that he was guard of the train, and which was taking minerals from Buxton to Oldham. He had just given the signal to the driver to start, and was walking to his van when the explosion occurred, and he was thrown to the ground. The engine had only gone a very short distance. The weight of the train was 496 t. and the capacity of the engine 510 t.

Sergeant McDowell said that in company with Superintendent Brady he visited the railway sidings and found that an explosion had occurred and that the engine was badly smashed. They searched for the bodies, and found them in the plantation, and witness gave various gruesome details of the injuries the victims had sustained. The engine, he said, was terribly shattered and the rails beneath it torn away and doubled up like pin wire. The barrel of the boiler was practically intact, and so was the tender.

R. Winstanley, St. Helens, said he was a London and North-Western Railway engine driver, and knew the engine No. 134, which subsequently exploded, and brought it to Buxton from Widnes on Thursday 10 November. When he detected any defect in an engine it was his duty to record it in a book, and on this occasion he entered in the record book that « the steam gauge wanted changing, it was registering 300 lb.; both injectors would not work when high in steam, and the engine brakes needed adjusting ». When the gauge registered 300 lb. it was, in his opinion, out of order, or the safety valve was not working correctly. A fair limit of pressure was 200 lb. for an engine of that type.

Replying to a juryman, witness said that when the gauge was showing 300 lb. he did not think the pressure in the boiler was that.

In reply to Mr. Brassington (representing the National Union of Railwaymen) witness said that when the gauge showed 300 lb. the engine was standing, and he presumed it was out of order as the valves were not blowing off, the gauge was comparatively new, and the engine was an exceptionally good one.

Witness, continuing, said that when he found the gauge registering 300 lb., he got it down to 200 lb. because he did not trust it at the higher pressure. With the dampers closed he reduced it to 100 lb. and he kept the engine below blowing-off point. He felt no uneasiness until the gauge got above the 200 lb.

George Moss, Buxton, engine driver in the London & North-Western Railway employ, deposed to having prepared the engine for work the day previous to the explosion, and got it fit for the journey by about midnight.

By the coroner : If the fault was with the safety valve the changing of the gauge would not alter it. A new gauge had been put in, and there was a red mark on it when the steam should blow-off.

Mr. G. A. Dingley, Nantwich-road, Crewe, was the next witness, and said he was the assistant superintendent of the London & North-Western Locomotive Department at Crewe. When a report was made in the engine repair book it was the business of the foreman fitter to read every entry, after which he gave the work out to the proper men to do it. Regarding the entry in the book about the steam gauge it was his experience that the driver from working his engine would know what was wrong — the gauge or the safety valve — and this entry to his mind would suggest that the gauge only needed attention. They were not allowed to tamper with the valves as a seal was on them. If the next driver reported the gauge wrong, the safety valves would be taken off, and if he had any suspicion that there was something wrong with the valve the driver could touch a special lever. Witness described to the coroner and jury the construction and working of the valves, and said that if the foreman fitter should, in any special case, consider the valve was at fault, he should stop the engine, remove the valve from the boiler and send it to Crewe works for repair. Witness said he had examined the gauge and debris, but had not at the present moment arrived at what he considered to be the cause of the explosion. There were still parts waiting to be examined, but this could

not be done until after the Board of Trade examination fixed for the coming Friday.

Questioned by the coroner, witness said there were possible causes for the explosion; 1° the boiler being allowed to get short of water, the crown of the fire-box becoming hot, and the injectors put on which would cause a flow of fresh water into the boiler and produce a sudden raising of steam; 2° some foreign substance or explosive being thrown into the fire-box; and 3° the safety valves not acting properly. The first and second causes were the only two met with in his experience, covering forty years, but he had never heard or read of an explosion caused by a defective safety valve. He had a case of an explosion caused by a detonator being left among the coal by the colliers, but in reply to the coroner, witness said he could hardly imagine such an explosion as the present one arising from such a cause.

In reply to Mr. Brassington witness said the steam gauge had not been touched since the explosion, and would not be until the Board of Trade Inquiry. With regard to the safety valve, if the gauge was correct and the valve was not blowing-off they would have the valve removed.

By a juryman : The boiler barrel met with practically no damage; the fire-box had collapsed, but the crown of the box gave indication that it had gone first.

In reply to Mr. Mason (of the Associated Society of Locomotive Engineers and Firemen) the action of the lead fusible plugs would be to let the water in and put out the fire.

Witness proceeded to say that the driver would not have started if he had seen anything wrong with the gauge or valve. They could scarcely have gone wrong with only five strokes of the engine. The working life of a boiler would be from twenty to twenty-five years, and that of the fire-box about the same with repairs. There was one of the safety valves intact, and this would be examined.

Replying to the coroner, witness said he could hardly account for an explosive which would cause so much damage if it had been thrown on the fire. It might be possible for an explosive to blow off the fire-box roof and then explode after. The exploded boiler had been repaired by a private firm, and the fire-box was sixteen years old. He had no information as to whether the safety valve was blowing off at the time of the explosion.

Mr. James Denning, assistant works manager at Crewe, said that as a rule the London & North-Western Railway Company made all their boilers there. In the case of a boiler to work at 200 lb. there were three tests, the first being a steam test up to 100 lb. pressure; next a clamp would be put on the safety valve and the boiler tested hydraulically to 300 lb. pressure; the clamp would then be removed, the water dropped to the normal level, and the boiler fired up and tested to 200 lb. pressure.

The boiler in question was built originally by the company in 1905 and went through the tests. It was repaired at Crewe Works in 1907, 1908, 1911, 1914, 1916 and 1918. It was last repaired by Messrs. Beardmore, and went through the repair test up to 100 lb. pressure. It was last repaired by that firm in May 1921, and the boiler was received back in July, satisfactory so far as the work was concerned. Repairs to the fire-box the last time would be at Messrs. Beardmore's works.

The guard of the train, John Hannah, was at this point recalled by the coroner, and was asked whether he noticed any steam being blown off just before the train started. He replied there was none whatever.

Tom Halstead, Fairfield, Buxton, an engine fitter, said that the previous Thursday he changed the gauge on the engine 134, getting his instructions from the foreman. Nothing, to him, appeared to be wrong with the old one. The gauge he took off was comparatively a new one.

John Hardstaff, Buxton, foreman fitter at the London & North-Western sheds, deposed to the repairs made under his control.

By the coroner : When the gauge registered 300 lb. instead of 200 lb., it was probably wrong. In his experience of twenty-six years there was no possibility of the gauge being

right and the valve wrong. He had never experienced a safety valve being defective. Of course if a gauge was going up to 300 lb. when in perfect working order there must be a fault somewhere, but as stated he had not met with such a defect in a valve.

This for the present closed the evidence, and the coroner said the jury would agree with him that they could not possibly complete the inquiry that afternoon. Mr. Dingley had told them that there were three possible causes of the explosion : 1° Shortness of water, 2° some foreign substance getting underneath the boiler, and 3° there was the probability of the safety valve going wrong, which Mr. Dingley had said he had never before heard of. A large quantity of the debris of the engine had not yet been examined pending the Board of Trade Inquiry. It was possible that when that came to be carefully examined something else might turn up, and he (the coroner) would not feel comfortable if he let the jury give a verdict on the evidence now before them. He would therefore adjourn the inquiry until after the Board of Trade had completed their examination, and they would then have the benefit of their report. The date for the adjourned inquest could not be fixed, but it would be left open, and the jury would receive further information.

At the request of a juryman, Mr. Allan Tizard, West street, Crewe, inspector of boilers for the railway company, was called, and said that the repairs done to the fire-box were that two new half-sides were put in. The last time it was repaired was at Messrs. Beardmore's in May to July of this year, and he was present at the testing of the boiler previous to its being placed on the engine. The boiler was filled with water and hydraulically tested up to 205 lb. per square inch, and afterwards to a working pressure of 200 lb. of steam.

The inquest was continued at Buxton Hall on 9 December. The London & North-Western Railway Company were represented by Captain H. M. Beames, chief mechanical engineer; Mr. G. A. Dimley, assistant running superintendent; Mr. Denning, assistant works manager; and Mr. S. Stoker, assistant traffic superintendent. Messrs. Beardmore, who had made recent repairs to the engine, were represented by Messrs. Blacklock and Fawcett; and Mr. Brassington and Mr. Reinmer appeared for the National Union of Railwaymen.

The coroner stated that the deceased men, into the cause of whose death the jury were met to inquire, were William Holme, engine driver, of Springhead, Oldham, and Walter Fletcher, fireman, of Oldham, both of whom were instantaneously killed when the explosion occurred. He had had certain correspondence with various people since the jury had last met, and he thought the time had now come to clear the matter up so far as was possible, but he was afraid they would not be able to get very much further.

The first witness called was R. Winstanley, engine driver, who had brought the ill-fated engine to Buxton. At the last inquiry he stated that the steam gauge had registered a pressure of 300 lb. on the square inch, and he now, in reply to the coroner, stated that when he brought the engine to Buxton the night before the explosion he did not travel at an unusual rate, but had a light train.

Captain Beames, of Crewe, chief mechanical engineer of the London & North-Western Railway, said he would like to give his evidence in the form of a general statement. In the first instance, he wished to convey to the relatives of the deceased his own and his company's sympathy with them in their great loss, his own especially because their deaths were due to the explosion of a boiler which came to a large extent under his maintenance. The various parts of the engine which exploded had been removed to the Crewe works and carefully examined. The boiler in question was sixteen years old and in excellent condition, and had been repaired in 1921. So far as could be seen the repairs both to the boiler and engine were carried out efficiently. The boiler had been maintained in perfect condition throughout its life. Since the explosion a most careful examination had been made, at the works, and he had come to the conclusion that the first part of the boiler which

fractured was the crown of the fire-box. This was clearly shown by certain markings on the back of the fire hole, showing that the back plate was in position when the crown plate came down, and they had to look for the cause of that particular plate coming down. The only thing which had been found fractured were two roofing bar links, as they called them, on the left hand side at the back of the boiler. Some of the roofing bar pins were bent and others were sheared through. Tests which had been made of important parts showed that the material was excellent and more than conformed to the British Standard specification. That led them to assume what would be the condition taking it for granted the crown of the fire-box had collapsed. The tests carried out from material parts showed tensile strengths of 37 and 38 tons per square inch.

Assuming that the boiler contained 4 1/2 tons of water, which would take 2 hours to raise to a temperature corresponding to a steam pressure of 150 lb. per square inch, it would have stored up in that boiler what, if it had been allowed to escape in two hours,would mean about 1 980 000 000 ft.-lb. of energy. If they assumed that amount was allowed to escape in a fraction of a second the result would be very much the same as a violent explosion. Therefore, be (witness) assumed that there had been a very excessive pressure in the boiler. This was borne out by the results; the fire-box was blown out in four different directions, which was quite consistent with that theory. That brought them to the next point and led them to ask what was the cause of the roof of the box collapsing.

The Coroner : So far as you have gone, do we draw the inference that the cause of the explosion was the top of the box collapsing? You do not apparently suggest anything but that?

The witness, in reply, said that they found markings on the plates which convinced him and his colleagues that the top of the fire-box was the first part to go. Had it been the back of the boiler or the front they would not have found the markings they did. As he had previously stated, they found the material excellent, though there were certainly two roofing bar links broken.

Witness proceeded to say that as a matter of satisfaction he had carried out tests to destruction of an engine, similar to the one which exploded, but two years older. They obtained an hydraulic test pressure up to 600 lb. per square inch on the boiler, when one of the roofing-bar bolts was found to be partially fractured. This let the pressure out, thus finishing the test. The fire-box was in a most excellent condition still, but the crown had sagged down slightly, owing to the great pressure, and that again led them to assume that there was a very excessive pressure in the boiler which had exploded.

The evidence given before the coroner and the Ministry of Transport officials pointed to the fact that the steam gauge was reported to be registering 300 lb. per square inch, prior to the accident. The gauge had been tested in his presence and the presence of the Ministry of Transport officials, and was found to be practically correct, or within a matter of 10 lb. either way, which was quite immaterial.

They had had evidence put before them to the effect that up to a certain date the safety valves of the exploded boiler had blown freely and consistently. That was up to either September or October. Subsequent to that date it did not seem, so far as the evidence went, that the safety valve had been known to blow-off. They, therefore, carried out tests on the safety valve, or what remained of the safety valve of the engine, with a view to satisfying themselves whether the valve had stuck or not. There were two wing valves, and one was blown out, and the lever bent right round. The other was in place, the lever and spring being intact. They had carried out several examinations and tests but had not found any evidence — conclusive evidence — to show that that valve was stuck at the time of the explosion. He said that because the front wing valve was free when examined. Of course, it must be remembered the lever was quite bent. With regard to the safety valve not

working satisfactorily, witness said it was a most unusual occurrence. They had 3 400 engines on the London & North-Western Railway, each of which was fitted with two of those valves, and they could not find in the history of any man in the employ of the company evidence of the lever of a safety valve sticking. That was a defect that had been known to take place elsewhere, but not on the London and North-Western Railway. His own impression was that it was a defect in the safety valve that was the cause of the accident. There was one thing he had left out and which, witness said, he wanted to make perfectly clear. An examination of the crown of the fire-box showed conclusively that the top of the box had not been dry. The lead plug was intact, and the plates did not show the scorched condition they would otherwise have done.

The coroner remarked that it seemed to be the belief on the part of the London & North-Western Railway officials that it was impossible for the safety valve to be out of order.

Witness replied that that was the impression on that railway certainly.

The coroner pointed out that other theories put before the court were that the boiler had been allowed to get short of water, but that was negatived by the fact of the state of the fire-box crown. Another possibility mentioned had been that some foreign substance had got into the fire-box with the coal, but had there been, they would expect to see the fire-box blown upwards, whereas the point of greatest failure was downwards.

Witness, in reply, said he had had considerable experience of high explosives before, during, and since the war, and he always found that they struck the point of greatest resistance. Had it been on the bed of the fire it must have been forced downwards, and had it been anything in the nature of dynamite, glycerin, guncotton, or any other « ites », he would not in his opinion, expect to find the general soaring effect in that case. It would be difficult to imagine anything to produce those results.

The Coroner : Do you consider that when the engine was brought in, and the gauge was found to have registered up to 300 lb.; that the driver or the fitter, or the foreman fitter, should at that stage have drawn the conclusion that the valve might be defective?

Witness replied that he thought the average driver on the North-Western would assume the gauge was wrong, and would trust to the valve. The entry made in the book was what, in his opinion, could be expected.

The coroner said that what they had to decide in this case was whether the different people concerned acted reasonably, and whether the driver fairly discharged his duty by making that particular entry in the book.

Witness replied that so far as the London & North-Western was concerned he was responsible purely for the mechanical appliances. The drivers and firemen did not come under his ruling.

A Juryman : With regard to the sticking of the valve. If the valve had already stuck, the effect of the explosion might free it?

Witness : It might.

Juryman : It was tested afterwards, but you cannot rely on that for everything.

Witness : Quite so.

Juryman : How can the engine driver try the valve?

Witness : Outside the cab, by moving his lever.

Captain Beames said that the Ministry of Transport and himself had not agreed upon the cause of the safety valve sticking.

A Juryman : You would not like to express an opinion as to the cause of the valve sticking?

Captain Beames : It would not be fair to give an opinion.

This concluded the taking of evidence. The coroner in summing up said he thought that was all the evidence they could have in the case, and on that evidence the jury must give the best verdict they could. Of course, he reminded them, they were not sitting there

with any idea that they were expert engineers, but to give a simple answer to a simple question. That was whether the deaths, respecting which they were inquiring, had occurred as the result of what was commonly called an accident — that was an event which could not reasonably have been prevented by the exercise of ordinary care — or whether it was due to neglect by some persons who had a manifest duty to perform. They had got that much further since the adjournment, whereas if they had given a verdict the last time, the matter would still have been in doubt as to which one of the three possible causes put forward by Mr. Dingley was the correct one. They were now driven back to the conclusion that why the gauge was showing too much pressure was that the valve was not acting in a satisfactory manner, but the exact cause they did not know. What caused the valve to stick had not yet been agreed upon, but they had to ask themselves, was anyone to blame for a manifest neglect of duty? It had been said that on the North-Western a case of a valve going out of order had never been known amongst the higher or lower ranks. The valve was looked upon as a kind of bible, and could not possibly go wrong. That left the impression that the men concerned could not be expected to do more than they did. Had they done everything that was reasonable, or ought they to have satisfied themselves that the valve was out of order? That was the point he originally felt a doubt about.

The jury retired to consider their verdict and were absent about half an hour. On their return the foreman Alderman Cooper, said:

« The jury are all agreed. The conclusion we have come to is that these men met with their deaths through the accidental bursting of a locomotive boiler.

« The jury recommend that a stopcock should be placed on the steam pipe under the gauge to enable the fitter to shut off steam whilst replacing the gauge, and enable him to test the new gauge under the same pressure. The jury is of opinion that more care might have been taken to see that it really was the fault of the gauge before the engine was sent out the second time. » An expression of sympathy with the bereaved relatives was made on behalf of the jurymen by the foreman. »

[656 .251]

5. — The utility of colour light signals.

(*The Railway Gazette.*)

On 27 July 1921, the Minister of Transport appointed a Committee on Light Signals with the following terms of reference :

a) To investigate the potentialities of light signals on British railways;

b) To examine light signals under trial, and recommend for further trial or scientific investigation any devices which are or may during investigation become available;

c) To form conclusions in regard to economies to be obtained at various locations, to draft outline specifications for design, to consider energy supply and to present a report.

The report of the Committee has recently been published and an important opinion is expressed as to the possibilities of colour light signals. We reprint the report in full.

REPORT TO THE MINISTER OF TRANSPORT.

In accordance with the directions contained in the minute of constitution the Committee have investigated the potentialities of light signals, and they have pleasure in reporting that definite and unanimous conclusions have been arrived at on this subject.

It was realized from the outset that the subject must be regarded from two aspects, one being the broad question as to whether light signals, in some known form, could in general answer the purposes for which the semaphore form of signal is now used, and the other to ascertain the best and most suitable form or type of light signal now existent. In pursuing the subject it has been borne in mind

that light signals as known to-day have not yet reached finality of design, and in putting forward their views the Committee have done so with the idea of helping progress in this important subject by making recommendations which are as elastic as possibe. At the same time endeavour has been made to eliminate points which have been found unsatisfactory, and to prevent ground being retrodden which has already been explored and found unproductive of satisfactory results.

The Committee are indebted to the directors and the managing officers of the Liverpool Overhead Railway Company for the facilities given to inspect the colour light signals installed on this line. The signals were seen during brilliant sunshine, and when the sun was immediately behind and also in front of the signals, and it was noted that signals over 1 000 yards distant were distinctly visible in these conditions. The Committee were also favoured with an opportunity to inspect an experimental position light installation at Wimbledon (London & South Western Railway), the conditions as regards sunlight being the same as at Liverpool. The Committee were satisfied in each case that the degree of visibility of light signals in daylight was efficient, and would meet practical requirements.

Colour light and position light signals.

The two main types of light signals at the present time are :

a) Colour light, in which indications are given by the use of the same colours as are employed to-day, *viz.*, red, green and yellow;

b) Position light, in which indications are given by a series of white lights which simulate by their arrangement the various positions taken up by a semaphore arm, *viz.*, horizontal for danger, and inclined or vertical for warning or clear respectively.

The Committee are of the opinion that the colour light type with separate lenses for each colour indication offers marked advantages over the position light type on the one hand, and light signals with moving mechanism on the other; and that the first-named is the most suitable, and the most likely to commend itself for adoption on British railways, both from a practical point of view as well as being cheaper in first cost and maintenance. All further discussions and recommendations deal, therefore, with the former colour light type of signal. The Committee are also of opinion that this type of signal could be arranged to meet, as far as can be seen, all conditions now covered by the existing semaphore type.

The question of costs has been by no means an easy one. In the first place, the Committee appreciate that comparisons are being made with costs of manual and power signal apparatus, which years of experience in competitive and bulk manufacture have reduced to a minimum, and on the other hand costs for light signals are being based on much shorter experience and on manufacture in small quantities, anyhow, in so far as this country is concerned; but it is anticipated that with further experience and manufacture in greater quantities the cost of the light signals can be considerably reduced in the future.

Comparative installation costs.

The Committee have been faced with the difficulty as to what would be fair comparative installations on which to base costs. In the case of a comparison between an isolated manually worked semaphore signal at 500 yards, and a colour light signal at the same distance from the signal cabin, there is probably little difference in the costs of installation and maintenance. The determining factor in a comparison, however, is not the length of track equipped, but the density of signals per mile; and the greater this is, the greater the probable saving in favour of light signals. It should be observed, moreover, that the use of colour light signals includes most, if not all, of the advantages obtained from power-worked semaphores (whether automatic or non-automatic) at a considerably lower cost. For the foregoing reasons, the Committee consider that the financial advantages to be obtained from colour light signals apply more particularly

to congested districts where power is available, and especially in large station yards and terminals; and that for sparsely signalled areas the advantages of the light signals can be obtained with little difference in cost as compared with mechanical semaphores.

Further economies will be obtained in that lighter and cheaper structures could be employed in the case of gantries and overhead bridges; dolls and posts on such bridges would not be required; help weights and similar mechanical appliances for easing the signalman's work would be dispensed with; and, broadly speaking, the advantages of power-worked signals obtained at a lower cost. Signals could be mounted on simple posts in cuttings or confined locations, where, owing to insufficient space, an overhanging reversed type of bracket post would be required in the case of a semaphore arm. In many cases the height of signals, particularly on signal bridges and with bracket signals, could be 4 to 5 feet less with the light signal, because the extra height which is now necessary for the operation of the semaphore arm in the lower quadrant could be dispensed with. Further, economies in material and saving of effort could be obtained when dealing with slotted signals.

Fog repeater signals might be abolished.

The obviously greater penetrative power of the light signal type of lamp, showing as it does a focused beam, makes it superior in fog to the long burning oil lamp in general use. This appears to offer economies by avoiding the use of fog repeater signals which might otherwise be necessary, under certain conditions.

The Committee are of the opinion that a multiplicity of types and sizes of light signals should be avoided, and consider that three should be sufficient to cover all requirements, namely :

a) Running signals : long range;
b) Running signals : short range;
c) Shunting signals.

In *a*) the signal to be visible at a maximum distance of 800 yards in bright sunlight, assuming a 5 degree dispersion of the light beam. This condition can be met, at present, with a consumption of about 25 watts per signal lamp. With regard to *b*), the Committee consider that it would be preferable for the signal mechanism and case to be identical with *a*), but that a smaller lamp (*i. e.*, less candle power) should be used to suit local conditions. In the case of *c*) the signal could be modified to the extent of a smaller lens, lower candle power lamps, and wider dispersion of the light beam.

In the case of conditions of curvature, etc., which affect the continuous sighting of the signal, the Committee consider that any difficulties can be dealt with as they arise by increasing the candle power of the lamp, and the dispersion of the light beam. With regard to general visibility of the signals, the Committee consider that it is necessary for the light beam to be so arranged that it will be in a driver's field of view from the sighting point to a point as close as possible to the signal itself. On gantries and bridges the height of the signals can be lower than with semaphore arms, the most suitable position being floor level, using if possible the gantry or bridge as a background.

A. C. supply recommended.

With regard to the question of energy for source of light, the Committee are of the opinion that electricity is the only practical and economical method of dealing with the matter. Alternating current supply offers great advantages over the direct current system, enabling power to be distributed more economically due to high voltage transmission, and a low voltage supply to be given to the signal lamps by means of a simple transformer.

The Committee wish to emphasise the necessity of using a lamp of the « focus » type, in order to procure the utmost efficiency of the light beam. These lamps are to-day more readily procurable for operation on low voltage.

The Committee are of the opinion that power could be transmitted using the ordinary telegraph and telephone pole lines, up to

250 volts with braided conductors, and 2 200 volts on a suspended cable. The Committee are also of the opinion that the use of primary and secondary batteries is not an economical proposition for isolated signals, and that the chief advantage of secondary cells would be when used as a standby to the general power supply.

The absence of a standard frequency is to be deplored. The Committee are of the opinion that frequencies of 25 and 60 cycles are the most suitable. Frequencies lower than 25 increase the cost of apparatus, and, above 60, the cost of energy. Any contactmaking devices for completing circuits for operation of light signals as are now in use for power-operated signalling could be employed. The provision of artificial backgrounds does not appear to be necessary.

The Committee point out that it will be necessary with this type of signal to resort to electrical means for detecting the signals through switch points in cases where such detection is required.

Indications of signals.

With regard to the indication of the signals in the cabin, the Committee recommend that this should be accomplished in such a manner that it proves that current is actually passing through the focus lamp in the signal, and also shows which particular lamp (red, green or yellow, as the case may be) is energised. It is considered that the lamp type of repeater is preferable to the instrument type for this purpose.

Having considered the question of drafting specifications for design, the Committee are of the opinion, for reasons already expressed in paragraph (2), that any specification should be as broad as possible, and, further, that any departure from this course would perhaps have a hampering rather than a helpful effect on this important question. The optical system is the most important factor in the design, and the Committee limit themselves to observing, in this connection, that with the present state of knowledge, lenses alone offer certain advantages and appear preferable to reflectors or combinations of reflector and lens, as the production of phantom indication is less likely to occur with the lens alone. It is axiomatic to state that the trend of design must be to find a means of projecting in the beam the maximum percentage of the light supplied by the source of illumination, and it may be found that research into this question will produce methods whereby the maximum projection efficiency will be obtained by using other means in combination with the lens, without introducing the danger of phantoms, and also reducing the energy consumption of lamps which is required to-day.

The Committee are of opinion that whatever form of lens is used in the outside of the lamp, it should have a smooth external surface, thus preventing the lodgment of snow or foreign matter. Lamp bulbs, sockets and caps, of standard size, should be used, the latter of the bayonet type, and to British Engineering Standards Association specifications. It is considered that the mounting of the lamps should include means for adjusting the lamp in all directions, in order to obtain accuracy of focus, with a device for locking it when in position.

Range of visibility.

It is essential with this type of signal that if the focus lamp burns out or fails, the signal should not be entirely dead or dark, although it should be evident that the failure has occurred. This condition can be met by the provision of a standby lamp located in close proximity to the focus lamp, this standby lamp being energised on all occasions when its focus lamp should be alight. To eliminate as far as possible failure of both lamps, they should be run below their rated voltage. The range of visibility of the signal with the standby lamp burning alone should not be less than 40 % of the range given by the focus lamp, or 320 yards in bright sunlight.

As it is desirable that the number of contacts in any circuit should be reduced to a minimum, the Committee suggest the consideration of some system whereby the circuit by which the red lamp is energised is never broken.

The Committee consider no special remarks are called for in connection with relays or similar devices, any of these which are suitable for power installation of a similar pressure being also suitable for light signals. With regard to transformers, the Committee consider that these should, in all cases, comply with British Engineering Standards Association or Institute of Electrical Engineers' specifications for insulation tests and rating. The Committee are of the opinion that extensive hoods over the signal lamps are generally undesirable and are not required.

The Committee point out that consideration should be given to the provision of some means of distinguishing between automatic and controlled signals, as is done in the case of semaphore arms.

Potentialities of colour light signals.

To summarise briefly the conclusions arrived at, the Committee are of the opinion that the colour light signal has potentialities which are worthy of the serious consideration of British railways. The chief advantages of light signals which this investigation has brought out are :

a) They compare, at present, favourably in initial and maintenance costs with manual and power operated semaphores, and future development will doubtless allow this type of signal to show further advantages in this direction;

b) They make for other economies already enumerated;

c) The same indication is given to drivers by night and by day, and always of a definite character;

d) This type of signal is less prone than the semaphore to show a doubtful or wrong signal indication due to outside interference;

e) They can be easily adapted to two or three positions, automatic, semi-automatic, and manual signalling;

f) They are more easily controlled and slotted than the manual signals.